

PRACTICAL

ELECTRONICS

MAY 1982

75p

1.35

**SPECIAL
TEST GEAR
ISSUE**

*Includes these
exciting projects!*

**SIGNATURE
ANALYSER**

0892

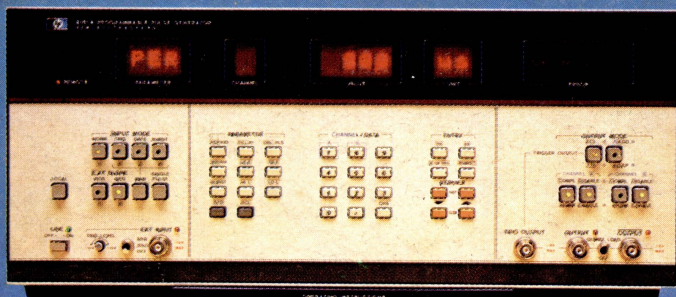
**FUNCTION
GENERATOR**



**FREQUENCY
METER**

12370005

Plus FREE SUPPLEMENT...



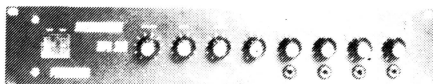
**IEEE-488 IEC-625
INTERFACE BUS &
AUTOMATIC TEST
EQUIPMENT**

POWER PACKED — by POWERTRAN

Powertran's black boxes are packed with punch. Not only are they superb kits to buy and build they really do the job! Imaginative and ingenious design goes hand in hand with top quality materials and outstanding performance capability. With their smart black styling the kits harmonise visually as well as musically.

You can build each unit independently for its set task and then gradually increase your array until you have a complete bank of formidable controllable power.

THE FIRST
WORDS AND
THE LAST
WORD IN
ELECTRONIC
KITS



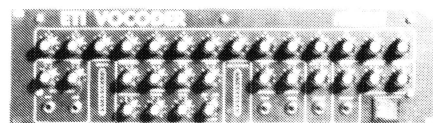
Complete Kit — £49.90 + VAT

MPA 200 — is a low price, high power 100W amplifier. Its smart styling, professional appearance and performance, make it one of our most popular designs. Adaptable inputs mixer accepts a variety of sources yet straightforward construction makes it ideal for the first-time builder.



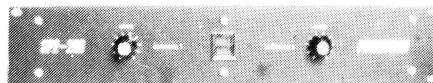
Complete Kit — £49.50 + VAT

Chromatheaque 5000 — a 5-channel lighting system powerful enough for professional discos yet controllable for home-effects. Sound to light, strobe to music level, random or sequential effects — each channel can handle up to 500W yet minimal wiring is needed with our unique single board design.



Complete Kit — £175.00 + VAT

ETI Vocoder — 14 channels, each with independent level control, for maximum versatility and intelligibility; two input amplifiers — speech/external — each with level and tone control. The Vocoder is a powerful yet flexible machine that is interesting to build and, thanks to our easy to follow construction manual, is within the capability of most enthusiasts.



Complete Kit — £64.90 + VAT

SP2 2000 — twice the power with two of the reliable, durable and economic amps from the MPA 200; fed by separate power supplies from a common toroidal transformer. Superb finish and quality components throughout — up to (even over!) the standard of high priced factory-built units.



STOP PRESS: NEW FROM POWERTRAN DIGITAL DELAY LINE

THROW AWAY ALL THOSE EFFECT PEDALS — THIS ONE'S GOT THE LOT

Ranging from phasing right through to distinct echoes with up to 1.6s max delay, all at the push of a button. Just select delay required for chosen effect.

FEATURES INCLUDE:—

EFFECTS — REVERB (all types) CHORUS — PHASING — FLANGING — ADT — ECHO & MANY MORE
Delay from 0.31ms to 1.6 sec expandable in 400ms stages.

Sweep modulation. Variable speed and depth. Repeat and freeze of delayed signal with no degradation in quality of recycled information. Great for building up unique backing accompaniments. Also allows pitch to be varied up and down.

High and low input sockets.

28.5K and 1.5K respectively.

Level control with overload LED.

Mix control of dry and delayed signal.

This unit is an absolute must for both the professional studio user and amateur electro-musician.

Just compare the specification with units costing upwards of £1,000. Unbelievable value!

Kits start at £130 + VAT with 400ms delay. 400ms add on delays £9.50 + VAT. Up to a maximum of 1.6 sec.



.... Quite simply the best way to make music



PORTWAY INDUSTRIAL ESTATE, ANDOVER, HANTS SP10 3WN
(0264) 64455.

PRICE STABILITY: Order with confidence. Irrespective of any price changes we will honour all prices in this advertisement until May 31, 1982. If this month's advertisement is mentioned with your order. Errors and VAT rate changes excluded.

EXPORT ORDERS: No VAT. Postage charged at actual cost plus £1 handling and documentation.

U.K. ORDERS: Subject to 15% surcharge for VAT. No charge is made for carriage, or at current rate if changed.

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit. FREE ON ORDERS OVER £100.

SALES COUNTER: If you prefer to collect kit from the factory, call at Sales Counter. Open 9 a.m. - 12 noon, 1-4.30 p.m.

Monday-Thursday.



MORE SUPERB KITS IN OUR
CATALOGUE



PRACTICAL ELECTRONICS

VOLUME 18

No. 5

MAY 1982

CONSTRUCTIONAL PROJECTS

FREQUENCY METER AND PRESCALER <i>by Stephen Ibbs</i>	24
Digital readout to 200MHz with 600MHz option prescaler	
PROGRAMMABLE TIMER/CONTROLLER Part 1 <i>by T. J. Johnson</i>	32
Digital clock/controller for mains operated appliances	
SIGNATURE ANALYSER <i>by A. Trebar</i>	42
An instrument for testing and debugging digital circuitry	
FUNCTION GENERATOR <i>by Andy Flind</i>	50
Provides sine, square and triangular waves throughout the audio range	
STEREO CASSETTE DECK Part 2	57
Construction and testing	
ULTRASONIC VISION SYSTEM Part 2 <i>by Jeremy Bentham</i>	66
Software, setting up and conclusion	

GENERAL FEATURES

SEMICONDUCTOR UPDATE <i>by R. W. Coles</i>	49
Featuring LM363 TL783 74HC Series	
MICROBUS <i>by D.J.D.</i>	62
ZX80 and ZX81 ideas	
INGENUITY UNLIMITED	68
12W FET PA—Morse tone detector—Bandpass filter—Electronic multimeter	

NEWS AND COMMENT

EDITORIAL	17
NEWS & MARKET PLACE	18
Including two-page Test Gear Special	
INDUSTRY NOTEBOOK <i>by Nexus</i>	23
What's happening inside industry	
BAZAAR	29, 47, 54
Buy, sell and swap service for readers	
SPECIAL OFFER—SPEECHTIME CLOCK KIT	41
Extra-low price for this innovative design	
SPECIAL OFFER—CASSETTES	46
Regular bargain offer on high quality cassettes	
SPACEWATCH <i>by Frank W. Hyde</i>	55
Extra-terrestrial activities chronicled	
SPECIAL OFFER—LOUDSPEAKERS	65
Hi-fi speakers at a very low price	
PATENTS REVIEW	72

SPECIAL SUPPLEMENT

AUTOMATIC TEST EQUIPMENT <i>by D. Mandelzweig</i>	between pages 40 & 41
The IEEE bus and its applications	

OUR JUNE ISSUE WILL BE ON SALE FRIDAY, MAY 14th 1982
(for details of contents see page 31)

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SPEAKERS
8Ω, 0-3W, 2"; 2.25", 2.5", 3"
80p
0-3W, 2.5" 40Q; 64Q or 80Q 80p

DIODES
AA113 15
BA100 15
BY100 24
BY126 12
BY127 12
CR033 280
OA9 40
OA70 40
OA72 12
OA79 15
OA85 15
OA90 8
OA91 8
OA95 8
OA200 8
OA202 8
IN161 5
IN164 5
IN4001/2 6
IN4003 6
IN4004/5 6
IN4006/7 7
IN4148 7
IN5401 16
IN5404 16
IN5406 17
IN5408 19
IS44 9
IS921 9
6A/100V 40
6A/400V 50
6A/800V 65

Noise Diode
Z5J 195

SCR's
Thyristors
0-6A/100V 32
3A/300V 38
5A/400V 40
5A/600V 48
8A/300V 60
8A/600V 95
12A/100V 78
12A/400V 95
12A/800V 188
BT106 150
BT118 180
C106D 38
C144 24
C145 29
C147 35
2N5062 32
2N5064 32
2N4444 130

DIAC
ST2 25

OPTO ELECTRONICS
LEDs including Clips
TIL209 Red 3mm 13
TIL211 Green 3mm 18
TIL212 Yellow 18
TIL220 2" Red 18
0.2" Yel, Grn, Amber
Rectangular LEDs with
two part clip, R, G & Y
Stackable LEDs
TIL220 2" Red 18
0.2" Tri colour LEDs
Red/Green
0.2" Bi colour LEDs
Red/Green
Green/Yellow
0.2" Tri colour LEDs
Red/Green/Yellow
0.2" Red High Bright
LD271 Infra Red (emit)
TIL32 Infra Red (emit)
SFH205 (detector)
TIL78 (detector)
TIL38
TIL81
TIL100 82

7 Segment Displays
TIL321 5" C.H. 115
TIL322 5" C.H. 115
DL704 3" C.H. 99
DL707 3" C.H. 99
DL747 3" C.H. 105
8" Orange C.A. 250
FND357 500 120
3" Green C.A. 140
±1.3" Red or Green 150
Bargraph 10 seg. Red 225

FERRIC CHLORIDE
1 lb bag Anhydrous
195p + 50p p&p

DALO ETCH RESIST
Pen + Spare tip 90p

COPPER CLAD BOARDS
Fibre Single Sided 9.5"x8.5" 95p
Glass Single Sided 9.5"x8.5" 95p
6"x6" 90p
6"x12" 150p

VEROBORDS 0.1"
Clad Plain 150
Vero Strip 144
DIP Board 330
S100 Board £14

VERO WRITING PEN and Spool
Spare Wire (Spool) 75p; Combs 310p

0.5" LIQUID CRYSTAL DISPLAYS
3 1/2 digit 550
4 digit 650
6 digit 750

ALUM. BOXES
3x2x1" 85
4x2x1" 105
4x2x2" 103
5x4x2" 105
5x4x2 1/2" 95
5x2x2 1/2" 130
5x4x1 1/2" 99
5x4x2 1/2" 120
6x4x2" 120
7x5x3" 150
8x6x3" 210
10x4x3" 240
10x7x3" 275
12x5x3" 260
12x8x3" 295

VERO BOARD
VQ Board 150
DIP Board 330
S100 Board £14

PROTO-DECs
Veroblock 375
S-Deck 350
Euroboard 620
Binboard 595
Superstrip SS2 £13

VERO WRITING PEN and Spool
Spare Wire (Spool) 75p; Combs 310p

SPECIAL OFFER
NE555 1+ 25+
2114L-3 16p 14p
2114L-2 87p 80p
2708 175p 160p
2532 395p 365p
2716 200p 195p
2732 400p 375p
4116 80p 70p
6116-150ns 450p 420p
6522 350p 320p
ORP12 78p 65p

CUSTOMER: How can Watford sell full spec devices so cheaply?
WATFORD: It's simple. By bulk buying (direct from manufacturers where possible), low overheads and smaller margins which give us an edge over our competitors.

ANTEX Soldering Irons
C15W 410
CX17W 425
CCN15W 425
X25W 440
Spare bits 50
Elements 200
Iron stands 160
Heat Shunt 25

GAS & SMOKE DETECTORS
TGS812 & 813 575
Sockets 40

ULTRASONIC TRANSDUCERS
40KHz Transmitter & Receiver 395p/pair

DIL SOCKETS (TEXAS)
Low Wire profile wrap
8 pin 8p 25p
14 pin 10p 35p
16 pin 10p 42p
18 pin 16p 52p
20 pin 20p 60p
22 pin 25p 70p
24 pin 25p 70p
28 pin 28p 80p
36 pin 105p
40 pin 30p 95p

DIL PLUGS (Headers)
14 pin 44p
16 pin 49p
24 pin 88p
40 pin 255p

National DigitaLinker IC Kit
131 words £39

ZERO Insertion Force DIL Sockets
24 way 595p; 28 way 850p; 40 way 975p

'D' CONNECTORS mini..(Cannon type) Solder Bucket

PCB Pins
25 way 200p
25 way 210p

EDGE CONNECTORS
Two rows
2x10 way 156p
2x15 way 135p
2x18 way 180p
2x22 way 199p
2x23 way 210p
2x25 way 225p
2x30 way 245p
2x36 way 295p
2x40 way 315p
2x43 way 395p
2x75 way 550p

WATFORD'S Ultimate Monitor IC.
A 4K Monitor Chip specially designed to produce the best from your: Superboard Series I & II, Enhanced Superboard & UK101. As reviewed by Dr. A. A. Berk In Practical Electronics, June 1981.
Price only £15.95 + 50p P&P.

IDC HEADERS
(Speed-block type) with IDC Headers PCB Plugs Ribbon Cable Grey p/foot
2x5 way 90p 85p 60p 65p 12p
2x8 way 130p 110p 70p 78p 18p
2x10 way 145p 125p 80p 92p 25p
2x13 way 175p 150p 95p 110p 35p
2x17 way 205p 180p 110p 135p 48p
2x20 way 220p 190p 125p 150p 56p
2x25 way 235p 200p 150p 175p 65p
2x60 way 230p 200p 220p 70p

EURO CONNECTORS
DIN 41618 31 way 180p
DIN 41662 2x32 way 295p
DIN 41612 3x32 way 385p

TRANSFORMERS (mains Prim. 220-240V)
6-0.6V 100mA; 9-0.9V 75mA; 12-0.12V 75mA 98p
6VA type: 6V-5A 6V-5A; 9V-4A 9V-4A; 12V-3A 12V-3A; 15V-2.5A 15V-2.5A 220p
12VA: 4.5-1.3A 4.5V-1.3A; 6V-1.2 6V-1.2A 12V-5A 12V-5A 295p (30p p&p)
24VA: 6V-1.5A 6V-1.5A; 9V-1.2A 9V-1.2A; 12V-1A 12V-1A; 15-8A 15-8A; 20V-6A 20V-6A 330p (44p p&p)
50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-2A; 2x30V-1A 2x30V-1A 440p (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x30V-1.5A; 2x40V-1.2A; 2x50V-1A 920p (60p p&p)

JUMPER LEADS Ribbon Cable Assembly
Length 14pin 16pin 24pin 40pin
Single Ended DIP (Header) Lead 140p
Double Ended DIP (Header) Lead 145p
6" 185p 205p 300p 485p
12" 198p 219p 315p 490p
24" 210p 235p 345p 540p
36" 230p 250p 375p 595p
Single Ended Socket Lead 24" 155p 210p 265p 300p
Double Ended Socket Lead 24" 290p 385p 485p 540p

COMPUTER CORNER

- VIC 20 MICROCOMPUTER.** Connects directly to a colour TV. 5K RAM expandable to 32K PET type graphics. £165
- CASSETTE DECK** for VIC20 including a free 6 programme Cassette. £39
- EPSON MX SERIES PRINTERS:** Full range available. Please phone for prices.
- SEIKOSHA GP100A** - Unihammer Printer, gives normal and double width characters as well as dot resolution graphics 10" Tractor feed. Parallel Interface standard. £195
- SOFTY-2.** As reviewed in PE September 1981. The complete microprocessor development system for Engineers & Beginners. New powerful instruction. Accepts any 24 pin 5V single rail EPROM. Supplied fully built, tested & enclosed in a black ABS case. Price inc. encapsulated plug in power supply. £169
- VIDEO MONITOR 9"** fully cased. B&W. Fully guaranteed. Excellent value for money at only £79
- TEX EPROM ERASER.** Erases up to 32 ICs in 15-30 min. £33
- TEX EPROM ERASER** with integral 30 min. Electronic timer £45
- Spare 'UV lamp bulbs** £9
- 5V/5A PSU** Ready built and tested £25
- Attractive Beige/Brown ABS CASE** for Superboard/UK101 or Home Brew £26
- Extra 4K of RAM** (8 off 2114L-300ns) £7
- Space Invaders** for Superboard £6
- Full ASC11** coded keyboard type '756' £39
- 4 x 4 matrix keypad** (reed switch assembly) £4
- C12 Cassettes** in Library Cases 40p
- 8 1/2" Fan fold paper** (500 sheets) (no VAT) £6
- 9 1/2" Fan fold paper** (500 sheets) (no VAT) £6
- Teleprinter Roll** (no VAT) £3.50

(P&P on most of the above items is extra)
Call in at our shop for demonstration of any of the above items. Be satisfied before you buy.

VOLTAGE REGULATORS

1A TO3 +ve -ve
5V 7805 145p 7905 220p
12V 7812 145p 7912 220p
15V 7815 145p 7915 220p
18V 7818 150p
1A TO220 Plastic Casing
5V 7805 50p 7905 55p
12V 7812 50p 7912 55p
15V 7815 50p 7915 55p
18V 7818 50p 7918 55p
24V 7824 50p
100mA T092 Plastic Casing
5V 78L05 30p 79L05 60p
6V 78L62 30p
8V 78L82 30p
12V 78L12 30p 79L12 60p
15V 78L15 30p 79L15 60p

LM300H 170 LM309K 135
LM304H 160 LM317H 280
LM305H 140 LM317K 350
78H05 5V/5A 550p LM317 95p
78H05 5V 50p LM323K 500
+24V 5A 599p LM326N 240
79H05 -2.25V to LM723 35
-24V 5A 785p TBA625B 75

SWITCHES

SLIDE 250V
1A DPDT 14 SPST 33
1A DPDT C/OFF 15 DPDT 44
1A DP on/off/on 40 4 pole on off 54

PUSH BUTTON
Spring loaded
Latching or Momentary 6A
SPST on off 99
DPDT C/OFF 145

MINIATURE
Non Locking
Push to make 15p
Push break 25p

ROCKER: 5A, 250V, SPST 28p
ROCKER: (white) 10A 250V SPDT 38p
ROCKER: With neon lights red when on 10A 250V, DPST 85p
ROCKER: (White) 10A/250V DPDT 72p
ROTARY: Make your own Multiway Switch. Shafting Assembly accommodates up to 6 wafers. 90p
Break before make Wafers. Silver contacts.
1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6 pole/2 way 65p
Mains DPST Switch to fit Screen & Spacers 45p
ROTARY: (Adjustable Stop Type) 1 pole/2 to 12 way; 2p/2 to 6 way; 3 pole/2 to 4 way; 4 pole/2 to 3 way 45p
ROTARY: Mains 250V AC, 4 Amp 56p

DIL SWITCHES: (SPST) 4 way 70p; 6 way 85p; 8 way 90p; 10 way 145p; (SPDT) 4 way 190p.

CRYSTALS

32.768KHz 100
100KHz 270
200KHz 295
455KHz 370
1MHz 392
1.8MHz 395
1.008M 290
1.8432M 290
2.0MHz 240
2.4576M 220
3.2768M 220
3.95954M 150
3.6864M 300
4.0MHz 200
4.432MHz 200
4.8MHz 200
4.194304M 200
4.433619M 120
5.0MHz 200
5.185MHz 300
5.268M 200
6.0MHz 220
6.144MHz 240
6.5536MHz 200
7.0MHz 200
7.168MHz 250
9.375MHz 350
10.0MHz 200
10.7MHz 220
10.24MHz 200
12.0MHz 290
12.528MHz 300
13.1818M 320
16.0MHz 250
18.0MHz 240
18.432M 240
19.968MHz 325
20.0MHz 325
24.0MHz 325
24.930MHz 325
26.69M 320
26.670MHz 325
27.648M 330
27.145M 240
27.125MHz 295
38.66667M 290
48.0MHz 270
100.0MHz 375
116.0MHz 300

ASTEC UHF Modulators
6MHz 280
8MHz Wide-bandwidth 425

WATFORD'S UNIVERSAL MICRO EXPANSION SYSTEM

Designed by Watford Electronics, this extremely versatile and economical Expansion System as published in E.T.I., starting from Dec., 81 issue, offers a low cost flexible expansion facility for ZX81, UK101, SUPERBOARD, ACORN ATOM, PET, TANGERINE, VIDEO GENIE, VIC 20.
The Motherboard (Interfaces with the Computer) has capacity to accept up to five daughter cards and can be paralleled for even more daughter cards. All PCBs are of Computer grade finish and are supplied in Kit form.

- Just look at the expansion possibilities:**
- MOTHERBOARD** - Accepts up to five Daughter Cards **Full Kit: £36.50**
- SOUND CARD** - Utilising up to three AY-3-8910 Sound chips. (one supplied with every Kit) **Full Kit: £24.95**
- PIO CARD** - Using two 6520 PIA chips, this Board offers Centronics parallel printer driver, digital to analogue converter and a host of other out-put facilities. **Full Kit: £19.95**
- PROM PROGRAMMER** - This simple but extremely useful card can blow 2716 or 2732 single rail EPROMS. **Full Kit: £25.95**
- EPROM CARD** - This card houses 4x2716 or 2x2532/2732. **Full Kit: £11.80**
- RAM CARD** - 8K RAM card. Accepts 16x2114 RAMs. The Board is supplied fully populated. **Full Kit: £28.50**

Coming soon: Disc Interface Card, 32K Dynamic RAM Card Speech Card & High Resolution Colour Graphics Card.

(N.B. PCBs may be bought separately)

WATFORD ELECTRONICS

Tel. (0923) 40588 Telex. 8956095

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Over 200,000 components as well as books, kits, service aids and hardware will be stocked.

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Personal callers welcome.

**208 BAKER STREET,
ENFIELD, MIDDX.**

Listed below are some of the items stocked

Adaptors
Adhesives
Aerials
Alarms
Aluminium boxes
A.B.S. boxes
Amplifiers
Audio leads
Audible warning devices

Batteries
chargers
connectors
holders
Bezels
Books
Boxes
Bridge rectifiers
Bulbs
holders
Busbars
Buzzers

Cable
clips
ties
markers
sleeving
wrapping
stripper
Capacitors
air spaced
trimmer
suppression
lead through
ceramic
electrolytic
polyester
polystyrene
silver mica
tantalum
Cement pre-sets
Chokes
Coilformers
Connectors
Coils
Continuity testers
Converters
Crimp tools
Crocodile clips
Crystals

Denco products
Demagnetisers
Desolder braid
Desolder pump
Diacs
Diodes
light emitting
photo
rectifier
signal
zener
germanium
infra-red
Displays
Drills
Earpieces
Earphones
Enamelled copper wire
Etch resist products

Filters
Ferric chloride
Ferrite cores
Ferrite rods
Fixing feet
Fuses
Fuse holders
Fluorescent displays
Field strength motors
Frequency counter
Gas sensor
Gronmets
Group panels
Grense

Headphones
Heat sinks
Inspection glasses
I.C.s
I.C. sockets
Infra-red source
Infra-red sensor
Indicators
Insulating tape

Jack connectors
Jewellers screwdrivers

Keyboards
Keypactor
Knobs
Lamps
Lamp holders
Leads
Liquid crystal displays
LED
LED arrays
LED displays

Mains adaptor
Matrix board
Memory I.C.s
Meters
Microphones
stands
Microprocessors
Morse key
Multistars

Neon bulbs
Ni-Cad batteries
Ni-Cad chargers
Opto electronic
Oscilloscopes

Panels
Pick-up coils
Pliers
Pre-sets
Potentiometers
P.C.B.s
P.C.B. transistors
Probes
Plugs
Pressure mats
Pre-amps
Photo electric relays

Rectifiers
Resistors
carbon film
metal film
metal oxide
wirewound
Ring cores
Regulators
Relays
Resistance chart

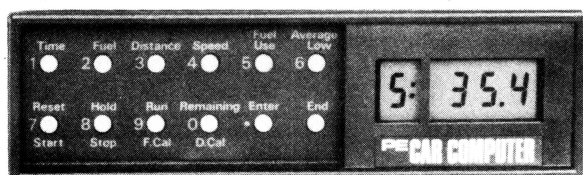
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Service aids
silver paint
switch lubricant
solder mask
silicone grease
anti-static spray
freezite
plastic seal
Aero klene
heat-sink compound
Aero duster

Spacers
SWR meters
Sockets
Sleeving
Solder
Soldering irons
Sirens
Speakers
Switches
mercury tilt
micro
reed
rocker
rotary
toggle
wafer
slide
push button

Test leads
Thermistors
Thyristors
Triacs
Transformers
main
audio
I.F.
Transistors
Transistor tester
Tag strips
Tinned copper wire
Transducers
Toroids
Terminals
Tuning coils
Tuning condenser
Ultrasonic receiver
Ultrasonic transmitter
Vero products

We are open from 9 a.m. to 6 p.m., Monday-Saturday

PE CAR COMPUTER



This unit was described by Practical Motorist as: "One of the neatest, most comprehensive and most useful of these car computers that we have yet come across..."

The PE Car Computer was designed to exceed the specification of all others, both for number of functions and accuracy. As well as the usual functions, it can perform eleven "remaining" type calculations, has a unique "start-stop" mode (used for acceleration timing and the like) and has a combination lock for driving an alarm or ignition cut-out.

The unit is housed in a custom designed box with high quality printed panels having an overall size of 165 x 50 x 80mm deep, and can be fitted above or below the dashboard. The display is liquid crystal for clarity in all lighting conditions.

The kit includes all sensors, wiring, etc and is suitable for all cars except those fitted with diesel or fuel injection engines.

Kit price: £78.50 Assembled Price: £88.50
+ £1 p&p includes VAT.

Send S.A.E. for list of separately available parts.

Goods by return of post.



PIMAC SYSTEMS LTD
20 Bloomfield Road, Moseley,
Birmingham B13 9BY.
Tel: 021-449 0384

ACORN ATOM

BK rom + 2K ram built £150. 12K rom + 12K ram built £198. Extra ram £2.10 per K. 4K rom £25. Power supply £10.20.

UK101 AND SUPERBOARD

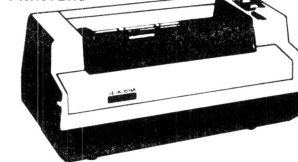
UK101 with 1K and free power supply and modulator kit £120, built £149. UK101 display expansion kit £14. The below accessories suit both the UK101 and superboard: Extra ram £2.10 per K. 16K memory expansion complete kit £50, built £58. 32K memory expansion kit £74, built £82. Cassette recorder £19. Cegmon £22.50. Wemon £19.95. Word processor program £10. Centronics interface kit £10. 510 expansion board £179. Cased minifloppy disc drive with DOS £275. The below suit only superboard: Colour adaptor board built £45. Assembler/Editor tape £25. Guard band kit £10. Series 1 only 30 lines x 50 characters display expansion kit.

NEW GENIE 1 £299

EG3014 Expansion box with 16K/32K ram £199/£213. Disk drive £220. Double density converter £72. Ldos £88. Newdos-£49. Ajedit disk word-processor £44. Colourboard £36. Parallel printer interface £36. Monitors: EG100 white £69. QVMPGR green £99. Colour Genie poa. Genie 3 poa.



PRINTERS



Buy any of the below and get a free interface kit and word processor program for UK101 or Superboard: Epson MX70 £259. Epson MX80T £359. Epson MX80F/T1 £395. Epson MX80F/T2 £430. OKI Microline 80 £295. OKI Microline 82A £399. Centronics 737 £335. Centronics 739 £419. Seikoshia GP80 £199.

SINCLAIR PRODUCTS*

ZX81 built + mains adaptor £69.95 (post £2.95 extra). SC110 Oscilloscope £129. PDM35 £32.95. DM450 £106.

BATTERY ELIMINATORS*

3-way type 6/7.5/8V 300ma £3.50. 100ma radio types with press studs 9V £4.95. 9-9V £6.25. Stabilized model 3/6/7.5/9V 400ma £7.95. Car converter 12V input, output 3/4.5/6/7.5/9V 800ma £3.00.

BATTERY ELIMINATOR KITS*

100ma radio types with press-studs 9V £1.79. 9-9V £2.50. Stabilized 8-way types 3/4.5/6/7.5/9/12/15/18V 100ma £3.12. 1 Amp £8.50. Stabilized power kits 2-18V 100ma £3.12. 1-30V 1A £8.50. 1-30V 2A £15.30. TTI and computer supplies 5V stabilized 1.5A £9. 3A £14. 6A £23. 12V car converters 6/7.5/9V 1A £1.62.

TV GAMES*

AY-3-8600+ kit £12.98. AY-3-8550+ kit £9.26.

BI-PAK AUDIO MODULES*

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T538 £2.90. AL60 £5.62. SPM80 £5.26.

BMT80 £6.36. Stereo 30 £19. AL80 £8.56.

VIC 20 COMPUTERS*

VIC 20 with free kit to allow use of a normal cassette recorder £165. Kit by itself £6. New low cost memory board. No need for a mother-board. Comes with 3K high resolution area + socket for a rom + sockets for 24K of ultra low current Nmos ram (plug in chips to expand memory) £49. Extra memory chips £9.75 per 2K. Vic printer £199. Joystick £6.52.



COMPONENTS*

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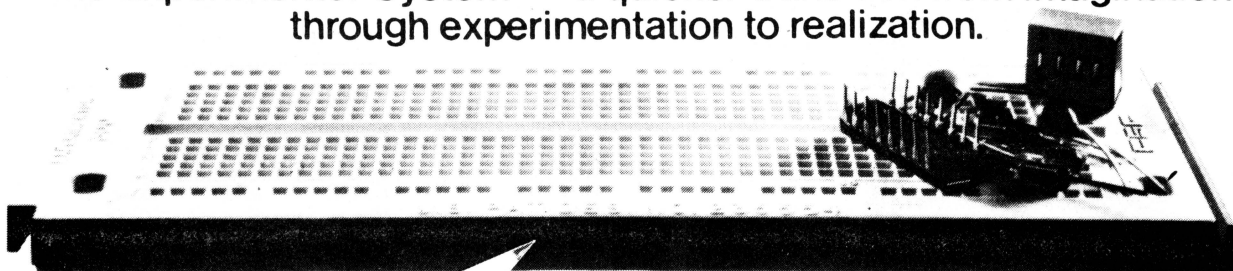
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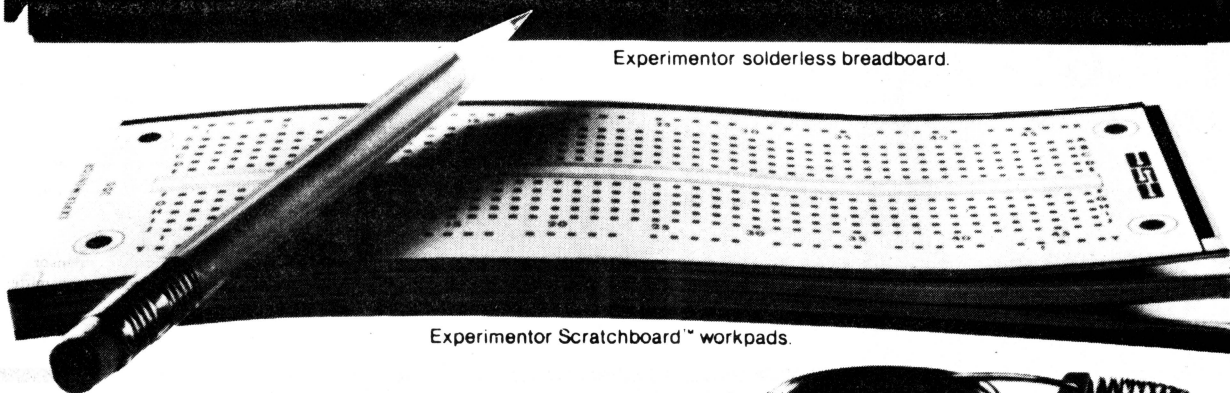
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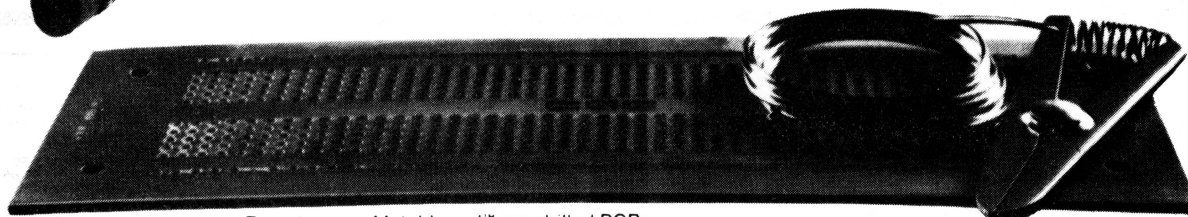
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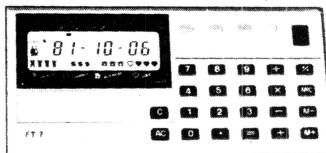
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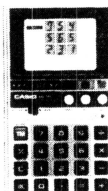
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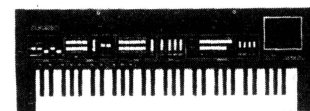
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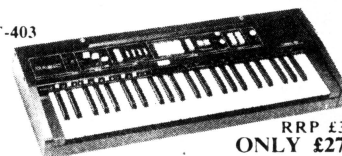
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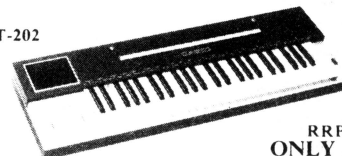
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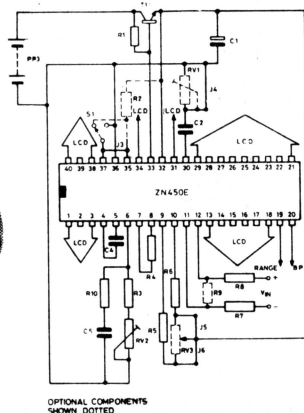
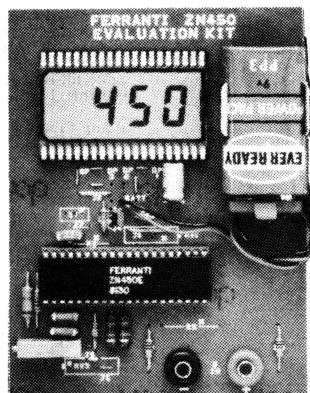
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In addition, provision is made on the printed circuit board for various options to increase the versatility of the DVM. Components required for these options are NOT provided but suitable values are indicated in the text. Additional applications data on the ZN450 is given in the data sheet.

Price: £19.95 each
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Device	Price	Device	Price	Device	Price	Device	Price	Device	Price
MEMORIES		LM555CN	0.16	CMOS 4000 'B'		4543	0.90	74LS190	0.40
2114L-200ns	1+0.93	LM556CN	0.49	SERIES		4553	2.90	74LS191	0.40
25+0.89		LM725CN	3.20	4000	0.11	4555		74LS192	0.40
2114L-300ns GTE	1.55	LM741CN	0.14	4001	0.11	4556	0.44	74LS193	0.40
(FOR ACORN ATOM)		LM747CN	0.70	4002	0.13	4585	0.82	74LS194	0.30
2708 450ns	1+2.25	LM748CN	0.34	4006	0.80			74LS195	0.30
25+1.99				4007	0.15	74LS SERIES		74LS196	0.50
2716 450ns	1+2.40	REGULATORS		4008	0.55	74LS00	0.10	74LS197	0.85
(single +5V)	25+2.25	7805	0.30	4009	0.28	74LS01	0.11	74LS221	0.54
2716 350ns	6.95	7812	0.30	4010	0.35	74LS02	0.12	74LS240	0.80
2532 450ns	1+4.50	7815	0.30	4011	0.12	74LS03	0.12	74LS241	0.80
25+4.25		78L05	0.29	4012	0.15	74LS04	0.12	74LS242	0.70
2732 450ns	1+3.99	78L12	0.29	4013	0.29	74LS05	0.13	74LS243	0.79
25+3.80		78L15	0.29	4014	0.58	74LS08	0.12	74LS244	0.85
2732 350ns	7.50	7905	0.55	4015	0.58	74LS09	0.12	74LS245	0.80
4116 200ns	1+0.74	7912	0.55	4016	0.25	74LS10	0.12	74LS247	0.83
100+0.67		7915	0.55	4017	0.45	74LS11	0.12	74LS248	0.83
4116 150ns	1+0.93	79L05	0.50	4018	0.58	74LS12	0.12	74LS249	0.83
4118 200ns	25+0.80	79L12	0.50	4019	0.29	74LS13	0.22	74LS251	0.40
25+3.45		79L15	0.50	4020	0.58	74LS14	0.30	74LS253	0.30
4118 150ns	6.00	LM309K	0.99	4021	0.80	74LS15	0.12	74LS257	0.40
5516 200ns	12.50	LM317K	3.20	4022	0.62	74LS20	0.12	74LS258	0.30
6116 200ns	7.00	LM323K	4.95	4023	0.17	74LS21	0.12	74LS259	0.79
6116LP 200ns	10.95	LM338K	4.75	4024	0.35	74LS22	0.12	74LS261	1.95
6116LP 150ns	10.85			4025	0.16	74LS26	0.15	74LS266	0.25
		280 FAMILY		4026	0.99	74LS27	0.12	74LS273	0.73
CRT CONTROLLERS		Z80 CPU	3.40	4027	0.30	74LS28	0.15	74LS278	0.50
EF6845P	9.50	Z80A CPU	3.90	4028	0.55	74LS30	0.12	74LS283	0.44
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EF9365P	62.90	Z80A DART	10.00	4033	1.80	74LS33	0.16	74LS293	0.45
EF9366P	62.90	Z80A DART	12.00	4034	1.55	74LS37	0.15	74LS365	0.34
EF9365/6 DATA AND APPLICATIONS	2.00	Z80A DMA	9.95	4035	0.72	74LS38	0.12	74LS366	0.36
		Z80A DMA	11.95	4040	0.54	74LS40	0.15	74LS367	0.34
		Z80 PIO	3.40	4041	0.89	74LS42	0.34	74LS368	0.40
		Z80A SIO-0	10.90	4042	0.59	74LS47	0.39	74LS373	0.74
		Z80A SIO-0	10.90	4043	0.59	74LS48	0.80	74LS374	0.47
		Z80A SIO-1	11.99	4044	0.84	74LS49	0.59	74LS375	0.74
		Z80A SIO-1	11.99	4045	1.85	74LS51	0.14	74LS377	0.80
		Z80A SIO-2	10.99	4046	0.88	74LS54	0.15	74LS378	0.80
				4048	0.54	74LS55	0.15	74LS379	0.80
				4049	0.26	74LS74	0.19	74LS386	0.28
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20 pin	0.14
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16 pin	0.31
18 pin	0.33
20 pin	0.35
22 pin	0.40
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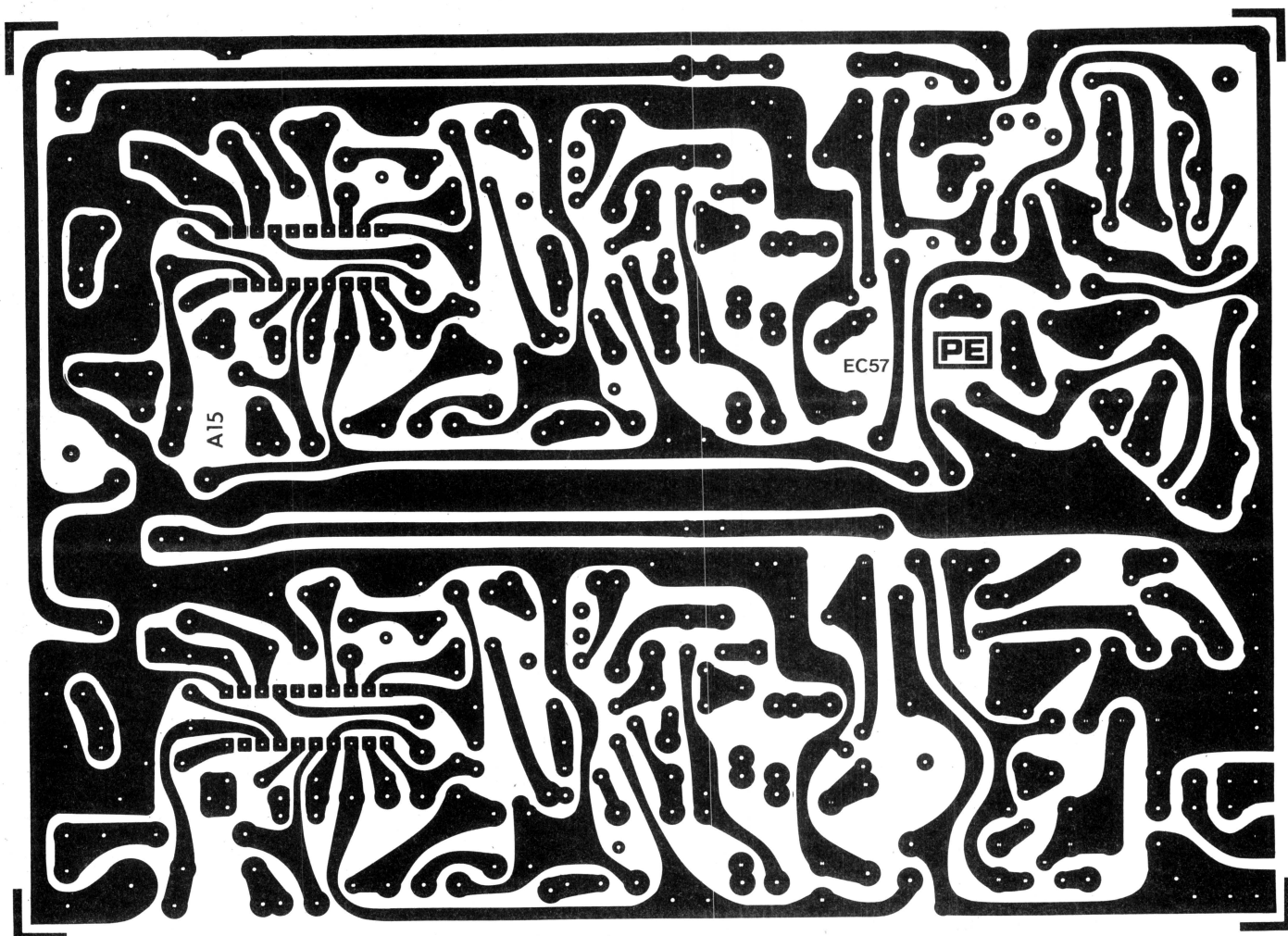


Fig. 1. P.c.b. design for the Quasar

'flat' position. The background noise should drop to an almost non-existent level (depending upon your amplifier). With the switch in the HF position, only the noise with high frequency content will be affected.

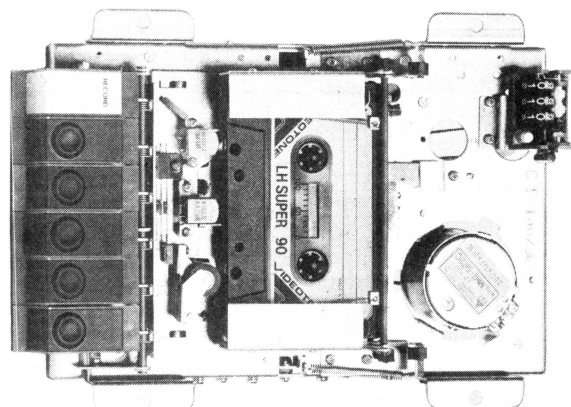
The GNR system can be checked during the on/off signal condition by pressing the pause key whilst playing the pre-recorded tape. It will be found that for sustained music the 'flat' position will be best. For tapes containing mostly quiet passages the 'HF' should be used; the presets PR2 can be adjusted for balance and to suit the sensitivity of each amplifier.

RECORD

To set the Quasar up on 'record', the p.c.b. should be hinged back so that L1 is accessible. When the fixing screws are removed a temporary earth should be connected between the p.c.b. and the deck chassis otherwise hum will result. Remember this earth must be removed when the unit is reassembled.

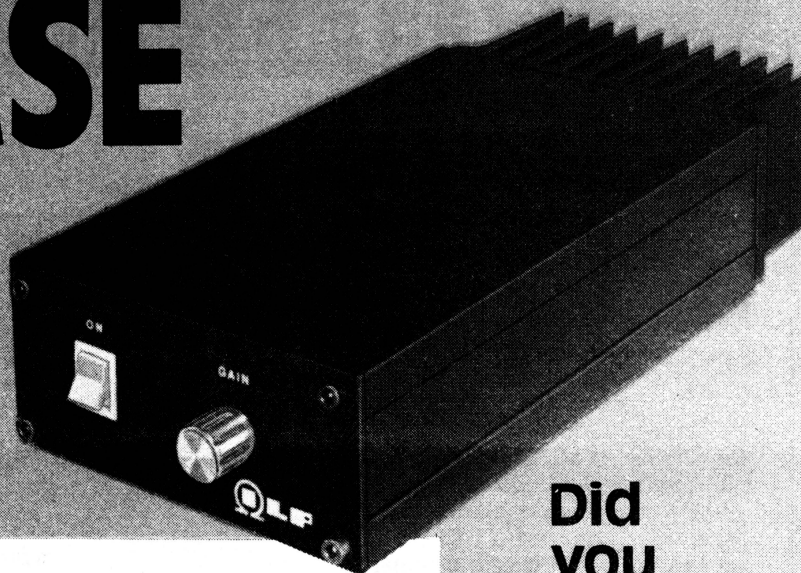
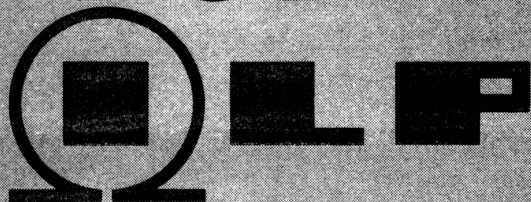
A blank tape should be inserted into the machine (with its rear tabs intact) and the bias level and EQ switch set to suit the tape used. A scope should then be connected between the earth and the junction of C17 and L1. Press the record button only and adjust L1 to obtain the minimum bias frequency reading. If a scope is not available then one channel can be used to monitor the other i.e. the left channel bias rejection can be monitored with the right hand VU meter and vice versa. This can be carried out by connecting the junction

of C17 and L1 to the DIN input of the opposite channel. The corresponding level control should then be adjusted to obtain a reading on the meter and L1 adjusted for minimum deflection. This procedure should be carried out for the second channel and then the temporary earth removed and the p.c.b. refitted under the mechanism.

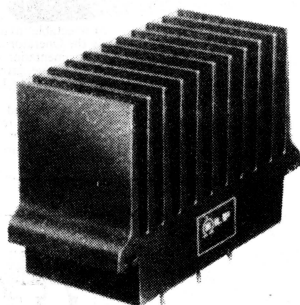


Photograph showing the top of the cassette mechanism. After the cassette mechanism has been mounted into the case and screwed into position the Perspex cover should be glued onto the two aluminium brackets mounted either side of the cassette compartment. Finally the offcut from the fascia panel legend should be trimmed and glued onto the cover.

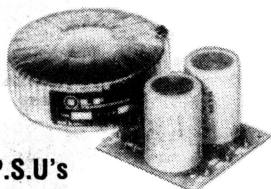
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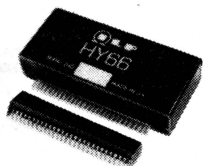
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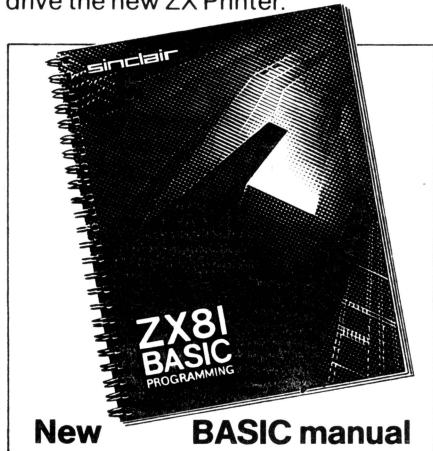
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With the ZX81, it's still very simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, and to drive the new ZX Printer.



Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs.

Kit: £49.⁹⁵

Higher specification, lower price – how's it done?

Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

New, improved specification

- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
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- Graph-drawing and animated-display facilities.
- Multi-dimensional string and numerical arrays.
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- Cassette LOAD and SAVE with named programs.
- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
- Able to drive the new Sinclair printer.
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.



Built: £69.⁹⁵

Kit or built – it's up to you!

You'll be surprised how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.



uter-



Available now- the ZX Printer for only £49.⁹⁵

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alpha-numerics and highly sophisticated graphics.

A special feature is COPY, which prints out exactly what is on the whole TV screen without the need for further instructions.

At last you can have a hard copy of your program listings – particularly

useful when writing or editing programs.

And of course you can print out your results for permanent records or sending to a friend.

Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your computer – using a stackable connector so you can plug in a RAM pack as well. A roll of paper (65 ft long x 4 in wide) is supplied, along with full instructions.

16K-byte RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

With the RAM pack, you can also run some of the more sophisticated ZX Software – the Business & Household management systems for example.

How to order your ZX81

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	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack.	18	49.95	
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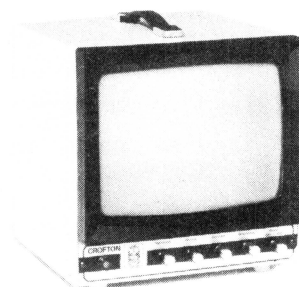
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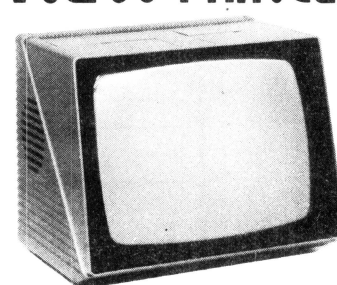
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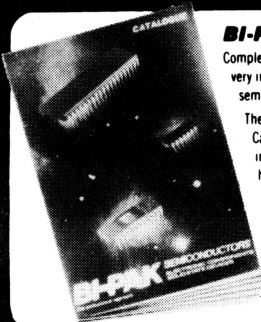
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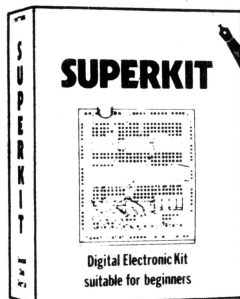
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DO YOU LONG TO HEAR YOUR DOORBELL RING?

Our latest kit gives you a pleasing three-note harmonically related tone sequence (not a microprocessor controlled buzz or the same old ding dong) at a touch of a button. This kit, based on a new integrated circuit, is supplied complete with a printed circuit board, loudspeaker and drilled box and requires only 9V battery and push button common to most households.



It may also be switched by logic in such applications as car alarms, clocks, toys, P.A. systems, etc. The unit produces a 150mW output and draws less than one 1uA from a PP3 battery when the tone ceases. Supplied complete with circuit and assembly instructions.

IDEAL PROJECT FOR BEGINNERS— ONLY £5.00

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Diac 118p
Opto isolated triac MOC3020 0.6A/400V 118p



THE KEY TO YOUR SECURITY IS IN OUR LOCK

If the thought of car thieves, house breakers or people tampering with your electrical and electronic equipment upsets you, have just the kit for you. Our ELECTRONIC LOCK KIT includes a 10-way keyboard and a special IC which provides a 750mA output to drive a solenoid or relay (not supplied) when four keys are depressed in the correct sequence. This gives over 5,000 possible combinations! The sequence is prewired and may be easily changed by means of a small plug and socket. A "SAVE" function is also available enabling the open code to be stored (especially useful in a car when it is left in a garage for servicing as the open code need not be disclosed). Size: 7x6x3 cms. Power Consumption is 40uA at 5V to 15V d.c.
At only £10.50 + VAT, it will make a smaller hole in your pocket than a bunch of keys! Electric Lock Mechanism £12.50
Suitable for use with existing door locks and above electronic lock kit.

THE MULTI-PURPOSE TIMER HAS ARRIVED

Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a 7 day cycle, e.g. to control your central heating (including different switching times for weekends), just connect it to your system programme and set it and forget it—the clock will do the rest.



FEATURES INCLUDE—

- 0.5" LED 12 hour display.
- Day of week, am/pm and output status indicators.
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- Useful "sleep" function—turns on output for one hour.
- Direct switch control enabling output to be turned on immediately or after a specified time interval.
- 20 function keypad for programme entry.
- Programme verification at the touch of a button.

THERE HAS NEVER BEEN A CLOCK CAPABLE OF SO MUCH AT SUCH A LOW PRICE— ONLY £45.00
(including components, assembly and programme instructions in an attractive case).

THE GARAGE DOOR AT YOUR COMMAND

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ALL PRICES EXCLUDE VAT

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LS04 .14	LS22 .15	LS55 .15	LS112 .24
LS05 .15	LS26 .18	LS73 .20	LS113 .24
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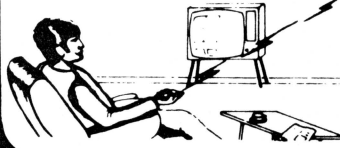


THE PERFECT AID FOR "LAZYITIS"

Our Lamp Dimmer Kit with INFRA RED REMOTE CONTROL will enable you to switch the lights on or off, and set the brightness, at a push of a button without leaving your armchair, water-bed, etc. Not only will you save time but it has also been estimated that the savings in shoe leather and carpet wear alone would pay for this unit in approximately 1.3697 years or more!



This unit has considerable practical uses, especially for the old, infirm and disabled. It works like a conventional dimmer, enabling you to switch the lights on or off, or to dim them to whatever brightness you require, by touch or using the hand-held infra red transmitter. When assembled, it fits into a plaster depth box to replace your conventional switch or dimmer with no rewiring.



TDR300K Dimmer Kit £14.30
MK6 Transmitter Kit £4.20
We also still sell our highly popular TD300K Touch Dimmer Kit at £7.00 and the LD300K rotary controlled Dimmer Kit at only £3.50

All kits contain all necessary components and full instructions. You only need a soldering iron and cutters.

24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to 1kW on and off at present times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triacs, PCBs and full instructions.



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CT1000K with white box (56/131 x 71mm)	£17.40
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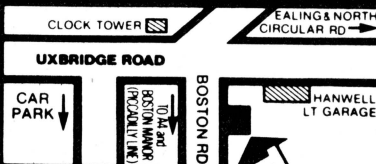
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LOOK

Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts i.e. semiconductors, resistors, capacitors, hardware, top cover, printed scale and mains transformer. You only supply solder & hook-up wire.

Self-assembly simulated wood cabinet. £4.50 + £1.50 p+p.

Featured in April issue Practical Electronics, reprint 50p - Free with Kit.

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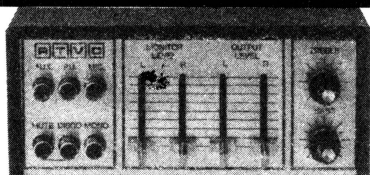
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P.E. STEREO CASSETTE RECORDER KIT

- NOISE REDUCTION SYSTEM
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STEREO AMPLIFIER KIT



- Featuring latest SGS/ATES TDA 2006 10 watt output IC's with in-built thermal and short circuit protection.
- Mullard Stereo Preamp module.
- Attractive black vinyl finish cabinet, 9" x 8 1/4" x 3 1/4" (approx).
- 10+10 Stereo converts to a 20 watt Disco amplifier.

To complete you just supply connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs - tape, speakers and headphones. By the press of a button it transforms into a 20 watt mono disco amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus power amp assembly kit and mains power supply. Also features 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia with matching knobs and contrasting cabinet. Instructions available, price 50p. Supplied FREE with kit.

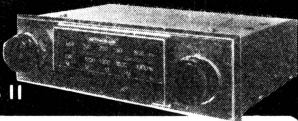
£16.50

+ £2.90 p+p.

SPECIFICATIONS:
Frequency response 40Hz - 20KHz
Input sensitivity P.U. 150mV. Aux. 200mV. Mic. 1.5mV.
Tone controls Bass ± 12 db @ 60Hz
Treble ± 12 db @ 10KHz
Distortion 0.1% typically @ 8 watts
Mains supply 220 - 250 volts 50Hz.

8" SPEAKER KIT Two 8" twin cone domestic speakers. £4.75 per stereo pair plus £1.70 p+p, when purchased with amplifier. Available separately £6.75 & £1.70 p+p.

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2 WAVE BAND, MW - LW

• Easy to build. • 5 push button tuning. • Modern design. • 6 watt output. • Ready etched and punched PCB. • Incorporates suppression circuits. All the electronic components to build the radio, you supply only the wire and the solder, featured in Practical Electronics. Features: pre-set tuning with 5 push button options, black illuminated tuning scale. The P.E. Traveller has a 6 watt output neg. ground and incorporates an integrated circuit output stage, a Mullard IF Module LP1181 ceramic filter type re-aligned and assembled, and a Bird pre-aligned push button tuning unit. Suitable stainless steel fully retractable aerial (locking) and speaker (6" x 4" app.) available as a complete kit. £2.50/pack + £1.50 p+p.

£12.95

+ £2.00 p+p.

BIRDAUDIO STEREO CAR RADIO BOOSTER

To boost your car radio or radio cassette to 15W r.m.s. per channel.

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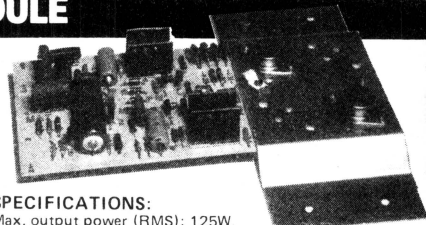


125W HIGH POWER AMP MODULE

KIT: **£10.50** + £1.15 p+p
BUILT: **£14.25** + £1.15 p+p.

The power amp kit is a module for high power applications - disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC board is back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

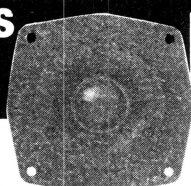
ACCESSORIES: Suitable mains power supply kit with transformer: £7.50 plus £3.15 p+p.
Suitable LS coupling electrolytic: £1.00 plus 25p p+p.



SPECIFICATIONS:

Max. output power (RMS): 125W.
Operating voltage (DC): 50 - 80 max.
Loads: 4 - 16 ohms.
Frequency response measured @ 100 watts: 25Hz - 20KHz.
Sensitivity for 100 watts: 400mV @ 47K.
Typical T.H.D. @ 50 watts, 4 ohms: 0.1%.
Dimensions: 205 x 90 and 190 x 36 mm.

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8 ohm soft dome radiator tweeter (3 1/4" sq.) for use in up to 40W systems; with 2 element crossover.

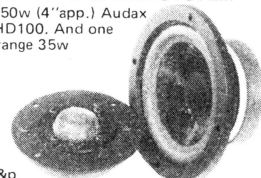
£3.50 each (p+p £1) or £5.95 pair (p+p £2).

35 WATT MICRO 2-WAY SPEAKER SYSTEM

Unit comprises one 50w (4" app.) Audax soft dome tweeter HD100, And one 5" Audax bass/midrange 35w driver HIF1JSM. Complete with 2 element crossover. Total impedance of system 4 ohms.

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PER SET + £2.70 p+p.



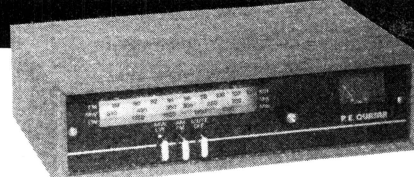
P.E. STEREO TUNER KIT

This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July 81 issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System. **FEATURES:** VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM - ferrite rod, FM - 75 or 300 ohms. Stabilised power supply with 'C' core mains transformer. All components supplied as to P.E. strict specification. Front scale size: 10 1/2" x 2 1/2" approx. Complete with diagram and instructions.

£17.95

Plus £2.50 p+p.

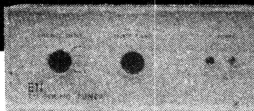
Self assembly simulated wood cabinet sleeve to suit tuner only. Finish size: 11 1/4" x 8 1/4" x 3 1/4". **£3.50** Plus £1.50 p+p.



SPECIAL OFFER! TUNER KIT PLUS:

- Matching I.C. 10 watt per channel Power amp kit. • Mullard LP1183 built pre-amp, suitable for ceramic pick-up and aux. inputs. • Matching power supply kit with transformer. • Matching set of 4 slider controls for bass, treble and volumes. **£21.95** + £3.80 P&P.

TV SOUND TUNER KIT



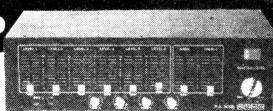
£11.45

+ £1.50 p+p.

As featured in E.T.I. December '81 issue. Kit of parts including PCB, UHF tuner and selector switch with all components excluding case.

• Transformer **£1.50 + £1.50 p+p** (p+p free on transformer if ordered with kit). • Ready built LP1183 Module for simulated stereo operation. **£1.95 + 75p p+p.**

MONO MIXER AMP



£39.95

+ £3.70 p+p.

50 WATT Six individually mixed inputs for two pick ups (Cer. or mag.), two moving coil microphones and two auxiliary for tape, tuner, organs, etc. Eight slider controls - six for level and two for master bass and treble, four extra treble controls for mic. and aux inputs. Size: 13 1/4" x 6 1/4" x 3 1/4" app. Power output 50 watts R.M.S. (continuous) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.

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TEST TEST TEST

This issue is a result of the many requests we get to publish more test gear. It seems that although we have been publishing regular test gear projects of various types you still want more. Our series of eight projects to fit the free case given with the May issue last year—yes, it's a year ago—were very popular and many of the instruments are now available ready made. The *Frequency Meter* published in this issue uses the same case and we can supply readers with these cases for 50p—details in the article.

Our most inventive test gear project is possibly the *Signature Analyser*. This item is quite a breakthrough in circuit design since it can perform the basic functions of instruments costing hundreds of pounds. For those familiar with signature analysis we feel this item will be very interesting. One other point on this project—the author is Yugoslavian and the project was sent to PE "out of the blue" from Yugoslavia. Yes we are read world wide and maybe the state of the art is at a higher level in some countries than

we in the UK believe, or are led to believe. Incidentally, on the same theme, our eight page supplement comes from a South African author and contributors to Microbus come from Iceland, Portugal, Sweden and Hungary; a truly international edition!

ON THE BUS

Of course much commercial test gear is now being made outside of Europe and the US. We have included a good selection of what's new in *News and Market Place*—it comes from all over the place.

The bus approach to automatic test gear is interesting and it is now possible for small businesses and hobbyists to construct a system using available chips, a few details are given in the supplement. If anyone is doing this or is interested in so doing please let us know. We could possibly arrange a series of projects on the subject given sufficient interest. It's your magazine so let us know how you feel about what we publish—or what we don't!

BAZAAR

If you are looking for test gear—or almost anything else in the hardware line—a scan through *Bazaar* might be worthwhile. This new feature in PE really finds its feet this month with about 90 ads. appearing—keep them coming, it's good for everyone.

Just a couple of points on *Bazaar* now it is in full swing. First, you must send in a *cut out valid* date corner—a copy of one will not do. Second, you must comply with the rules. Since the service is free to readers, in future we will not be writing to you if you do not comply with the above—your ad. will simply not appear. So make sure your ad. complies with the rules and make sure you send a cut out valid date corner—we don't need the whole page or even the whole coupon, if you want to keep your issue send us a copy of the coupon; but you must cut off the corner and send that in. It's not too much to ask and it is then fair to everyone.

Mike Kenward

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Editorial Offices:

Practical Electronics,
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Ian Sweeney

01-261 6676

01-261 6819

01-261 5897

01-261 6601

Technical Queries

We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in PE. All letters requiring a reply should be accompanied by a stamped, self addressed envelope, or international reply coupons, and each letter should relate to **one published project only**.

Components and p.c.b.s are usually available from advertisers; where we anticipate difficulties a source will be suggested.

Back Numbers

Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 95p each including Inland/Overseas p&p.

Binders

Binders for PE are available from the same address as back numbers at £4.60 each to UK or overseas addresses, including

postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions

Copies of PE are available by post, inland or overseas, for £13.00 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perry Mount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

...NEWS &

Edited by
Jasper Scott

Better than credit

A new era in buying petrol, with a debit card authorising the payment from a motorist's bank account in four seconds flat, began recently, in Scotland.

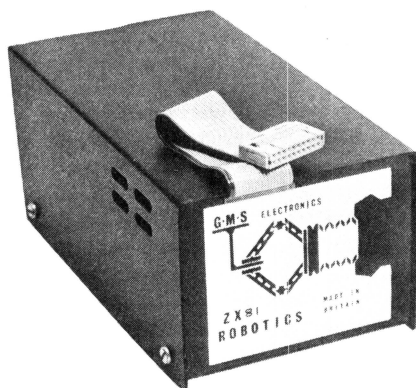
The debit card relies on micro-chips to carry out direct bank account deductions. And, say BP Oil and Clydesdale Bank, who are launching the new scheme in Aberdeen, this kind of debiting is what most motorists want.

Mr Chris Ensor, BP Oil's Site Facilities Manager, says, "Eight out of 10 motorists like to pay for petrol with cash. They regard petrol as a household expense along with groceries, which are accounted for in weekly or monthly budgets. In money terms they like to know where they are."

The scheme is called 'Counterplus'. Designed for customers with AutoBank cards issued by Clydesdale, Midland and Northern banks, it is the first time in the UK that a point of sale terminal, as opposed to a cash dispenser, has been linked directly and instantaneously to a bank.

Customers using this new facility won't need to hand over cash, to write a cheque or to wait while a credit card voucher is made out. They will simply use their cards, in the same way that they draw cash, to pay for garage purchases.

Looking further into the future Mr Ensor predicts that within five years most of Britain's prime service stations will be using an electronic fund transfer system like this.



Owners of the popular ZX81 personal computer can now upgrade from its rather immobile membrane keypad, and flimsy case (albeit smart in appearance) to a conventional keyboard with steel surround. The Crofton ZX81 Adaptakit places the ZX81 piggy-back on its own p.c.b. which houses the key-switches, and a video amplifier for direct monitor interface. A l.e.d. also gives indication of 'power on'.

The ZX80 p.c.b. is positioned so that its input and output connectors pass through holes in the Crofton case. The 16K RAM

ZX81 ADD-ONS

A robot interface unit has been developed by GMS Electronics for the ZX81 microcomputer. The mains powered unit's steel case measures just 100 x 70 x 180mm, and with 16 channels, of which the 8 inputs are rated at 1A each the unit is a general purpose interface. It would, for example, conveniently drive a shop lighting display, or electromechanical machinery.

The I/O channels run at 6-12V nominal with a maximum rating of 48V, with external supply. Inputs are protected, and the outputs incorporate anti-spike devices.

An applications book with interconnection circuit diagram, instructions and simple programming are included in the price of £59.95, plus £2.50 p&p. Available from GMS Electronics, Unit 5, Cranbourne Close, Norbury, London SW16 4NG.



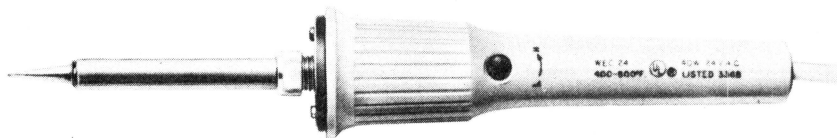
pack may also be plugged in through an aperture, and a support plate is provided to remove strain from the p.c.b. edge connector.

The key caps are made of clear plastic so that the symbol for any function may be inserted, and will not wear away. A two-colour, self-adhesive sheet of key-top labels comes with the kit. This gives a direct repeat of the ZX81's original keyboard.

With berillium contacts, the switches should provide one million trouble free operations.

The kit's fully inclusive price is £42.90. However, for an additional £8.62, plus a pristine cased ZX81 in part exchange, a ready converted system is available. Crofton Electronics Ltd., 35 Grosvenor Road, Twickenham, Middlesex TW1 4AD.

TEMPERATURE CONTROLLED IRON



The Weller WEC series are fully proportional electronic temperature controlled soldering irons. These irons give excellent response to loading and provide precise temperature control. Although they are factory calibrated to 371°C (700°F), they are fully user adjustable over a range of at least 204°C

(400°F) to 427°C (800°F), and are available in three voltages ranges—240, 120 and 24V. The temperature control and circuitry is contained within the handle.

The WEC series of irons is available from Toolrange Ltd., Upton Road, Reading, Berks (0734 22245).

MARKET PLACE

Items mentioned are available through normal retail outlets unless otherwise specified. Prices correct at time of going to press.

Briefly...

The Powertran advert on the inside front cover of last month's issue contained an error. In the advert, it was stated that the price for the complete kit of parts for the Digital Delay Line was £13.00 plus VAT. The correct price for the complete kit is £130.00 plus VAT.

• • • • •

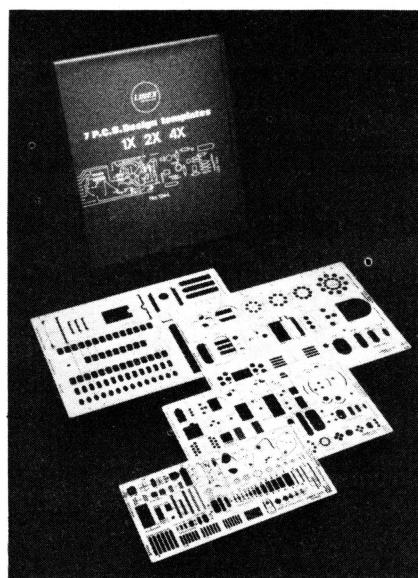
A new company has recently been formed to provide hobbyists, experimenters and small companies with high quality technology products. Initially, the company aims to concentrate on three areas—production tools/equipment, test gear and microelectronic products. Further details are available from Electronic Hobbies Ltd., 17 Roxwell Road, Chelmsford, Essex (0245 62149).

POINTS ARISING . . .

TV CAMERA (Jan–March '82)

The telephone number given for Security Electronics contained a printing error. The correct number is: 0733 239111.

PCB DRAFTING AIDS



A new range of electronic layout templates for printed circuit design has recently been introduced by LINEX of Denmark, and is of particular interest to both amateur and professional users who are involved in the design or production of printed circuit boards.

The templates are available in the scales of 1:1 (one template), 2:1 (set of 2) and 4:1 (set of 4) and they contain the most commonly used figures for printed circuit layouts, circuit views and component views. Component outlines include potentiometers, diodes, resistors, capacitors, dual in line, transistors, edge connectors etc., etc.

All component dimensions and terminals are given in millimetres and in tenths of inches, and dimensions are provided with mm and 0.1" divisions in the respective scales. All the templates in the series are produced with ink bosses so that they can be used for tracing with technical pens.

A comprehensive leaflet illustrating the templates is available and this leaflet suggests methods and instructions on how best to use the templates. For a free leaflet, or any other information, contact the sole UK agents for LINEX, Pelltech Ltd., Station Lane, Witney, Oxon (Telephone: Witney (0993) 72014 or 72130).

Countdown . . .

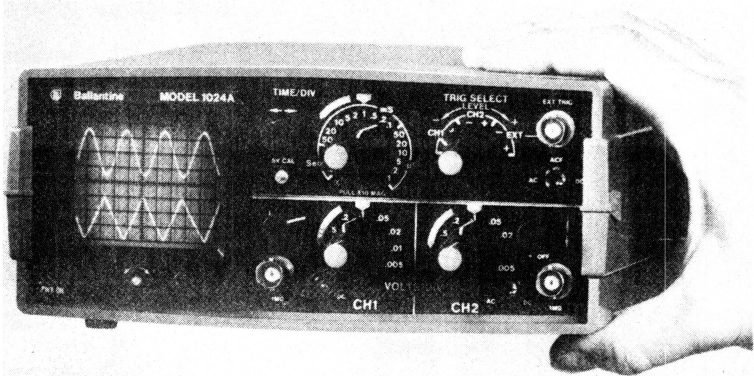
Please check dates before setting out, as we cannot guarantee the accuracy of the information presented below.

Local Networks & Distributed Office Systems Apr. 14–16. The London Tara Hotel. **O**
Int. Materials Handling Apr. 19–26. Earls Court, London. **I**
All Electronics Show Apr. 20–22. Barbican Centre, London. **E**
Communications Apr. 20–23. NEC. **I**
The Computer Fair Apr. 23–25. Earls Court, London. **Z1**
BEX Brighton Apr. 28–29. **K**
Compec Europe May 4–6. Centre Int. Rogier, Brussels. **Z1**
Defence Components Expo May 10–12. Brighton Metropole. **I**
The Micro Show May 11–13. Wembley Conf. Centre. **O**
HEVAC May 24–28. NEC Birmingham. **I**
Scotex Jun. 8–10. Roy. Highland Ex. Hall, Ingleston, Edinburgh. **A1**
BEX Leeds Jun. 9–10. **K**
Transducer/Tempcon Jun. 29–Jul. 1. Wembley Conf. Centre. **T**
BEX Croydon Jun. 30–Jul. **K**
Leeds Electronics Show Jul. 6–8. University. **E**

BAEC Amateur Electronics Jul. 17–25. Penarth Esplanade, S. Glamorgan. **B9**
Personal Computer World Show Sept. 9–12. Barbican Centre, London. **M**
Laboratory London Sep. 14–16. Grosvenor House. **E**
Two Counties Fair Sep. 15–18. Plymouth Ex. Centre, Millbray, Plymouth, Devon. **T**
Viewdata Oct. 12–14. Wembley Conf. Centre. **O**
Computer Graphics Oct. 19–21. London. **O**
Testmex Oct. 26–28. Wembley Conf. Centre, London. **T**

A1 Institute of Electronics, Rochdale, Lancs.
B9 BAEC, 26 Forrest Road, Penarth
E Evan Steadman, Saffron Walden ☎ 0799 22612
H1 Semtex Ltd. Tunbridge Wells ☎ 0892 39664
I ITF, Solihull ☎ 021-705 6707
K Douglas Temple, Bournemouth ☎ 0202 20533
L1 World Trade Centre ☎ 01-488 2400
M Montbuild ☎ 01-486 1951
O Online, Northwood, Middx. ☎ 09274 28211
T Trident Tavistock ☎ 0822 4671
V SDL ☎ Dublin 763871
Z1 IPC Exhibitions, Sutton ☎ 01-643 8040.

BALLANTINE PORTABLE



The new Ballantine 1024A mini oscilloscope, available from PPM Limited, has been designed to suit the needs of the field engineer, and light weight and small size have been achieved without reduction in instrument performance. The 1024A's specification is equal to laboratory bench scopes two or three times larger and heavier; it is shock and weather proof and will operate in harsh environments. The 1024A weighs 2.1 kilos and measures 87mm x 203mm x 220mm.

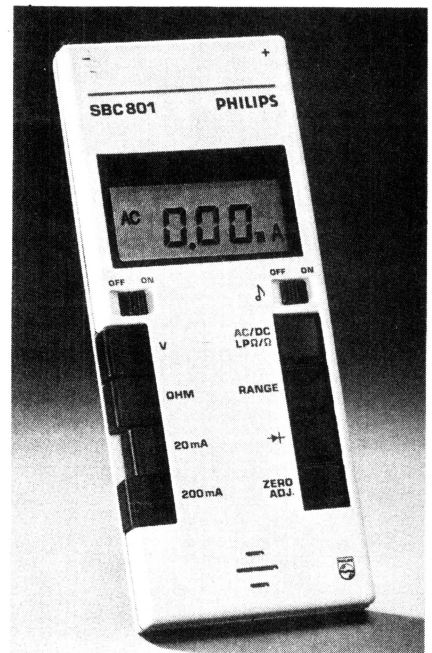
The Ballantine 1024A complements the existing 15 MHz model 1022A, also marketed in the UK by PPM, and gives extended performance with a 25MHz bandwidth in each of its two vertical input channels. The wide 25MHz frequency response extends 1024A use to fast signals, and the instrument has a passive delay line, so that the leading edge of fast rise pulses can be displayed when using internal triggering.

1024A applications include general purpose testing and maintenance in analogue and digital circuits, RF communications systems, computer peripherals, video equipment, industrial and process control systems, in telecommunications, medical instrumentation, and other fields.

PPM say that the scopes are reliable and run with less than a 9°C hot-spot rise in ambients from 0° to 50°C. The containing cases are dust, splash, and EMI proof. The shock and vibration resistant CRT and solid internal construction of the 1024A make it dependable in demanding field conditions.

Further information is available from PPM Ltd., Hermitage Road, St. Johns, Woking, Surrey GU21 1TZ (04867 80111).

PHILIPS SERVICE...



A range of test equipment is now available from Philips Service, Croydon. While much of the test gear they have to offer is very up-market—both in terms of price and performance, there are items in their range to suit the hobbyist pocket.

Pictured above is the Philips SBC801 pocket autoranging DMM. Its features include an alarm for continuity test work, a diode check range and zero adjust function. The SBC801 is supplied complete with test leads, carrying case and batteries, and is priced at £55.95 plus VAT.

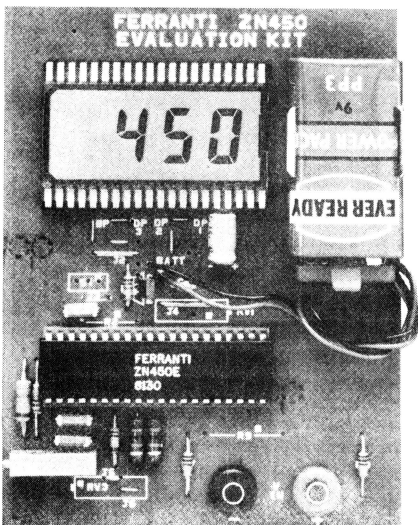
A digital logic probe, a range of three analogue multimeters and a regulated 1.5–30V 3A power supply are among other items in the Philips range which may be of interest to readers.

For further details, contact Philips Service, 604 Purley Way, Waddon, Croydon, Surrey CR9 4DR (01-686 0505).

EVALUATION KIT FOR DVM

Ferranti Electronics Limited has produced an evaluation kit for its ZN450, 3½ digit, single-chip, digital voltmeter integrated circuit. The kit includes a ZN450 and all the peripheral components and instructions necessary to produce a complete digital voltmeter. The kit enables designers and engineers to evaluate the performance of the ZN450 i.c. without the problems of designing and constructing a system from scratch.

The ZN450 is a complete digital voltmeter fabricated on a monolithic chip and requires only ten external passive components in order to function. Operating over the range



±199.9mV, the ZN450 also features an on-chip clock and precision reference voltage and consumes less than 35mW of power.

Apart from the more obvious uses as a DVM or multimeter, the ZN450 can equally well be applied to such devices as digital thermometers, pressure gauges and weighing machines.

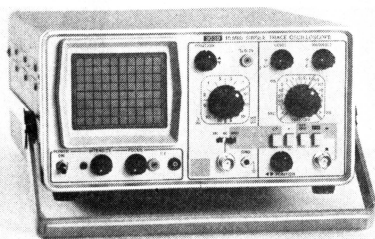
The DVM evaluation kit is priced at £19.95 including VAT, and is available through normal retail outlets.

TEST GEAR SPECIAL...

CROTECH SCOPES

Crotech Instruments Ltd., presently offer two 15MHz oscilloscopes—a simple trace model—the 3030, and a dual trace model—the 3131.

The 3030 (pictured here) has 5mV/div sensitivity, versatile time base with 200ns/div to 20ms/div sweep plus automatic and trigger level controls, triggering to at least 20MHz. A rectangular 95mm CRT gives around 40 per cent more viewing area than most competitive models.



The 3131 features 5mV/div sensitivity with full X-Y operation plus the extra feature of algebraic addition and subtraction. The timebase is fully constructed from 200ns to 0.2s/div with a versatile trigger circuit which operates to at least 35MHz and includes TV Field and line frequency modes.

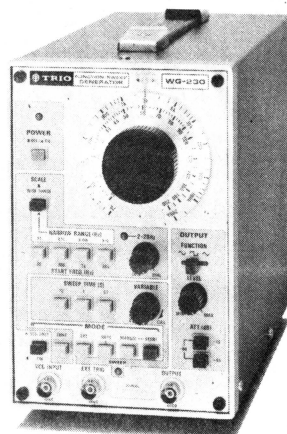
Both models feature a built-in component tester which allows both passive and semiconductor devices to be tested.

The 3030 is priced at £145 plus VAT, and the 3131 is priced at £230 plus VAT. Further details are available from Crotech Instruments Ltd., 5 Nimrod Way, Elgar Road, Reading, Berks (0734 866945).

FUNCTION, SWEEP & PULSE GENERATOR

House of Instruments inform us that they now stock the WG 230 from Trio, which combines the capabilities of a Function, Sweep and Pulse Generator in one compact unit. The wide frequency bandwidth is covered by a log and linear divided, high resolution main dial from 20Hz to 200kHz, with an auxiliary control covering the range 2Hz to 2GHz.

Four main types of output are available: Sine, Square, Triangle and TTL level Pulse. Output impedance is 600ohms with 7V r.m.s. sine and 10V pk to pk for square and triangle controlled by 60dB's of switched and 20dB's of variable attenuation. Flatness is better than 0.2dB making the WG230 ideal in determining frequency characteristics. The TTL pulse output can be used to drive logic circuitry or act as a clock source substitute. FM modulation, another convenient feature when measuring frequency characteristics over a specific band, is available via an external signal. External d.c. can be used for VCO applications while a useful sweep ramp output is provided for use as a time access control for oscilloscopes or pen recorders.



Up to five frequency decades can be covered in a single sweep with automatic sweep times being internally selected from 0.1 to 100 seconds both continuous and single to match the application. The single sweep mode can also be controlled manually from the front panel or sweep speeds determined by external signals. Automatic sweep speed compensating has been provided to maintain a constant sweep time period for any arbitrarily set width.

For further information, contact House of Instruments, Clifton Chambers, 62, High Street, Saffron Walden, Essex CB10 1EE. (0799 24922).

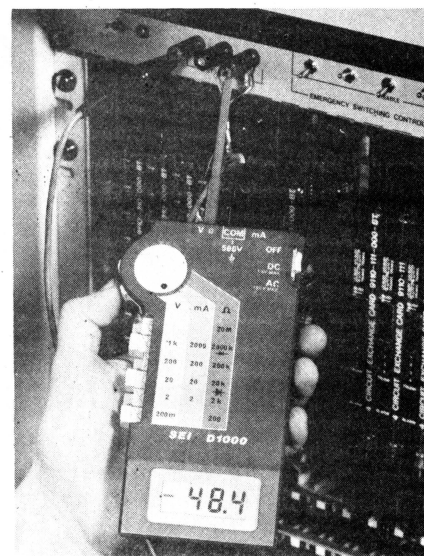
NEW SEI DMM

A new hand-held digital multimeter, designed for wide application in the computer and telecommunications testing and servicing markets, has been announced by SEI.

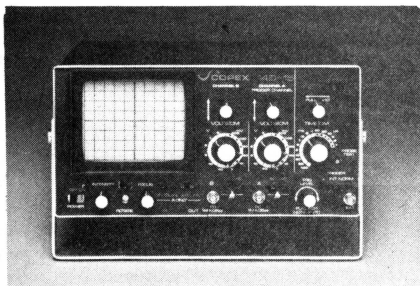
The input terminals are at the top, enabling the operator to 'probe' the circuit under test, whilst holding the instrument in one hand. The 3½ digit l.c.d. display is at the base, and is sloped for easier reading. The

meter covers a resistance range of 0 to 20MΩ, with diode test facility, and a voltage range 0 to 1kV (max) d.c. and 0 to 750V r.m.s. (max) a.c.

Further information is available from Salford Electrical Instruments Ltd., Barton Lane, Eccles, Manchester M30 0HL (061-789 5081).



SCOPEX



Scopex Instruments Ltd. of Letchworth, the independent British manufacturers, have announced an addition to their range of low cost, high performance oscilloscopes.

Designated the 14D15, this instrument is a 15MHz dual trace oscilloscope incorporating push button X-Y, add and invert facility, probe compensation and an active TV sync separator all as standard features.

This instrument was evolved from the 14D10 series of oscilloscopes. The 14D15 is priced at £250.00 plus VAT, which includes two probes and carriage (UK mainland). Further information is available from Scopex Instruments, Pixmore Avenue, Letchworth, Herts SG6 1JJ (04626 72771).

A NEW INTEGRATED DIGITAL MULTIMETER AND SCIENTIFIC CALCULATOR

COMPLETE WITH BATTERIES,
TEST LEADS, CARRYING CASE &
SPARE FUSE.

Only
£75.00

(Plus £3.00 p&p
and insurance)

A pocket sized digital multimeter with a coupled, eight digit, function calculator.

- DMM display with one-touch keying-in of the calculator.
 - Low power ohms for in-circuit resistance.
 - AC/DC 10M Ω Input Impedance.
 - Approx. 100 hrs (continuous) battery life.
 - Battery indication display light.
 - Diode check range.
 - Buzzer sounds when ...
 - 1) Range switch is operated.
 - 2) There is excess input for V and mA functions.
 - 3) There is continuity check for Ω function.
 - 4) The V, Ω and mA function switches are operated (except 20mA \leftrightarrow 200mA)
- Maximum input: 1000V d.c.
750V a.c. Ω -mA: Fuse (0.3A)
and Diode protected.
Dimensions:
170h x 76w x 20d (mm).
Weight: (approx) 250g.

- One hand operation of function and range switch: V, Ω functions: Full autoranging: 20mA, 200mA Ranges: Manual.

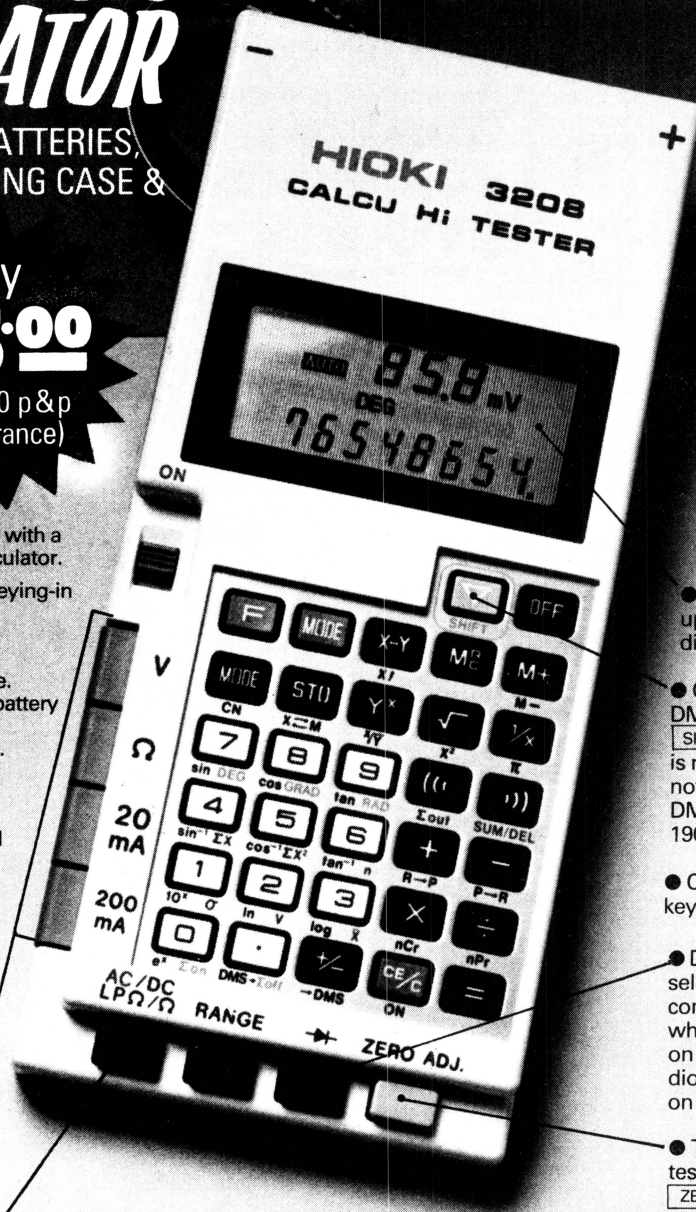
- Any range can be obtained with full autorange capability for dc V, ac V, Ω and LP Ω functions.

Dorman Smith Instrumentation

A division of Dorman Smith Fuses Ltd.

Salterbeck, Nr. Workington, Cumbria, CA14 5DT
Telephone: Harrington (0946) 830345
Telex: 64419 Dorman G

MEMBER OF THE BICC GROUP



- DMM display is on the upper and the calculator display on the lower register.

- One touch keying-in of DMM data. By pushing the **SHIFT** key the DMM figure is redisplayed in scientific notation e.g. When a 190.0mV DMM display is keyed-in, 190.0 $\times 10^{-03}$ is displayed.

- Calculator with full scientific keyboard.

- Diode check is carried out by selecting 200 Ω range, connecting diode to terminal whilst maintaining pressure on the **TEST** key. (The diode test can be carried out on the 200 Ω range only.)

- To obtain a zero display, the test leads are shorted and the **ZERO ADJ.** key is pressed.

To: Dorman Smith Instrumentation
Salterbeck, Nr. Workington, Cumbria, CA14 5DT

E1.1

Please send.....DMM/Calculator(s) at £78.00 each (inc. £3.00 p & p and ins.)
I enclose P.O./cheque made payable to Dorman Smith Instrumentation for
the amount of.....or debit my Access/Barclaycard.

No. _____



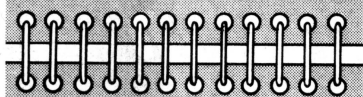
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ADDRESS _____

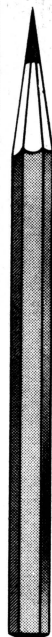
**Dorman
Smith**

Allow 21 days for delivery. Offer available in U.K. only.



INDUSTRY NOTEBOOK

By Nexus



That Word!

Whoever coined the word privatisation deserves a kick up the backside or a medal, I hardly know which. It is clumsy, even ugly, and yet it is hard to find another single word to express the process of transferring public (i.e. nationalised) industry to private capital and management in the interests of economic efficiency and improved customer service.

As well as being an ugly word, it must be an ugly idea to many of those who have enjoyed sheltered as well as profitable occupation through the years. It comes hard when one is faced with the cold (or hot?) blast of competition.

The mere threat of privatisation has positive effects. The partial breach of the telecommunications monopoly, for example, has already gingered up British Telecom. Chairman Sir George Jefferson is reported to have sent senior management and the trade unions a sharp note on poor performance and high overheads. BT pay went up 31 per cent last year for only a 4-6 per cent increase in business. And compared with their US counterparts BT field engineers made only half as many service calls a day.

BT in fact had a remarkable turnaround in its last half-year results, turning in £140 million profit compared with a £19 million loss in the same six months a year earlier. But this was mainly due to jacking up the cost to subscribers and had little to do with performance.

Alongside the appeal for greater efficiency there is also promised a revision of accounting policies and asset valuations. It is hinted that a more rational accounting system would reveal that profits are lower than claimed in the past.

The fact is that 'cooking the books' is by no means unknown in Government and, one assumes, in the organisations it directly supports and controls. This has been made abundantly clear by Joel Barnett who was Financial Secretary to the Treasury under Chancellor Denis Healey in the years

1974-79. In his recently published book *Inside the Treasury*, Joel Barnett writes that his previous experience as an accountant in juggling figures was as nothing to what he found in the Treasury with their 'massaging' and 'fudging' in presenting huge public expenditure figures.

Of course there is nothing criminally dishonest in such practices. Any set of statistics can be presented in many different ways and it is only human to put the best construction on them from your own viewpoint.

Nonetheless, if you are in business, which BT now is, rather than politics, then it should be beneficial to look hard facts in the face if the corporation is to be efficiently conducted.

The Micro

The message seems to be getting through that we are in the computer age. Advance publicity generated almost 100,000 enquiries for the BBC's Computer Programme. But what a pity there were technical difficulties (since resolved) that resulted in the series having to start with so few of the Acorn computers having been delivered to eager viewers. Production was speeded up to 2,000 a week to meet the demand. The BBC was just as embarrassed as the computer manufacturer but promises a repeat of the course for late starters.

Meantime Clive Sinclair is re-establishing his reputation as a whizz-kid with his ZX81 personal computer selling world-wide in its tens of thousands. And there are plenty of other makes to suit all pockets continually appearing.

But while a mass market for micros is now growing fast, the other bright mass-market hope of CB Radio has fallen short of expectations although not entirely a flop. Forbidden fruit is always sweeter and I note that now that CB is legal, in my area activity has fallen away rather than increased and nobody seems to have switched to legal f.m. from illegal a.m.

Research

The 1981 Annual Review, which has just arrived on my desk, from the Allen Clark Research Centre makes good reading. One hears so much of cuts in research spending, real or imaginary, from the universities that it is easy to start believing that working for the future has almost ceased. This is patently not so at the Plessey think tank and laboratories at Caswell, named after Plessey founder Allen Clark and established there since 1940.

J. C. Bass, managing director of the Allen Clark Research Centre, comments that: 'The competition to convert research and development into manufactured products increases in pace year by year and, correspondingly, electronic systems and devices become rapidly outdated and cease to be viable commercially. The race is an international event, there are some very strong competitors and we do not set the rules for it'.

I will give just one example of what he means. In a paper 'Monolithic Surface Acoustic Wave Convolver—Its Application

to Spread Spectrum Communications' J. J. Purcell of the Integrated Circuits Division records in his conclusion that this device is being actively developed in France, USA, Germany and Norway as well as in the UK. Although he doesn't say so possibly in the Soviet Union as well.

Flux

The electronics industry more so than most is in a constant state of flux. There are not only the great leaps in technology but also in the structure and goals of companies. Thus, Plessey has been streamlining and shedding peripheral activities to concentrate on mainline products. One of the early companies sold off was Garrard, a steady loss-maker at the time. Regrettably Garrard's new owners, based in Brazil, found they couldn't compete in the world hi-fi market by continuing production in the UK and it has now been transferred entirely to Brazil where production costs are lower.

Latest company to be shed is Plessey Resistors which will stay in the UK trading under the new name Citec. New owners are Ron Clark, formerly managing director of Plessey Components Division and two high-ranking Plessey colleagues including the MD of Plessey Resistors, David Stapleton, now MD of Citec. The purchase has bank support and the project is expected to obtain ample investment from the City. The workforce at Swindon is being retained and there is already talk of expansion.

There are now a number of examples where ex-employees have bought companies and the trend is likely to continue.

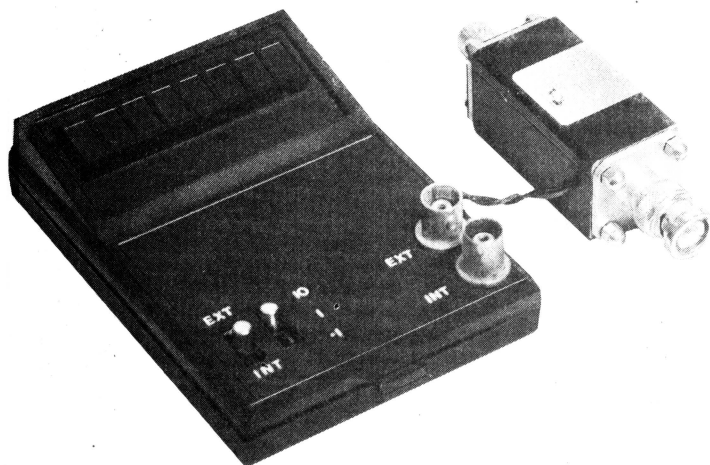
New Dimension

The Engineering Council, under the chairmanship of Sir Kenneth Corfield (chairman of STC), is now in existence after 18 months of wrangling over aims and objectives following publication of the Finiston Report which proposed enhancement of the 'engineering dimension' in British industry and education.

The Council's prime job will be to accredit academic courses and industrial training and to register engineers in their various categories. It's early days yet and until we have seen the Council in action, judgement must be reserved on whether there is any real improvement in the status of the engineer in society.

Embedded Optics

An ingenious combination of optical fibre and power line has been developed by BICC. The optical communications link is at the centre of an overhead power conductor, normally the earth line of an overhead power distribution system. The line will normally carry operational data, alarm signals and generating board messages. The first operational system should be installed in the UK over a 23km link by May this year, followed by a 74km system in Saudi Arabia under a £750,000 contract. A novel aspect of the system is that surplus capacity in the optical link can be leased to PTTs for public telephone use.



FREQUENCY METER AND PRESCALER

STEPHEN IBBS

THE project described here is a highly sensitive 200MHz 8-digit frequency meter, and, depending on the input waveform, will measure down to d.c. The prototype toggled at up to 220MHz! It uses the case given free by *Practical Electronics* last May. This measures approximately 102mm by 77mm by 25mm, and it will house a 9V battery, a 10-200MHz pre-amp and divide by 100 prescaler; switching logic, and the main 0-10MHz counter. Also packed in are two switches, two BNC sockets and an 8-digit display! All this shows that the constructor has to solder neatly, and take care with the mechanical side of the project. The meter is sensitive enough to require only a small piece of wire as an aerial pick-up; it has three gate times, and the logic provided to enable other inputs to be fed into the counter (using the second BNC socket) thus bypassing the preamplifier and prescaler, which is the unit described in *P.E.* in April 1980.

CIRCUIT DESCRIPTION

The main counter is the Intersil 7216B (0-10MHz) counter, which interfaces directly with an 8-digit display without the need for external driver i.c.s, using a 10MHz quartz crystal timebase. There are four versions of this i.c.

- A** = Universal counter. Common anode display,
- B** = Universal counter. Common cathode display (used in this project)
- C** = Frequency meter only. Common anode display,
- D** = Frequency meter only. Common cathode display.

The B version is a 28-pin d.i.l., and will measure:

- a)** Frequencies, up to 10MHz,
- b)** The ratio between two frequencies, feeding the second signal into pin 2.
- c)** Periods
- d)** Unit counts (e.g. useful for conveyor belts)
- e)** Time intervals, again using the second input.

It is only slightly more expensive than the 7216D, and provides so many more facilities that the author believes it to be worthwhile. The B was used in preference to the A

because Common cathode 8-digits were available in the author's shack. The pin-outs are different for each version.

It has four gate times: .01, .1, 1, and 10 seconds, with full 8-digit accuracy provided on the 10 second gate. The .01 gate is not used in this project because its usefulness is limited in frequency mode, and it enables the much more common, and cheaper, three way slide switch to be used. D1, D2, or D3 is connected via this switch to go to pin 14 to select the different gate times.

The 7216B will drive the displays direct, including the decimal points, but this is meaningless if a divide-by-100 prescaler is employed in front of the i.c. The Intersil data booklet provides details for external transistor drivers for the decimal point, but the limitation of space prevented these being included. If constructors require more information, they are referred to the booklet of lengthy code (408)996-5000TWX:910-338-0171.

The counter is a low power CMOS device, so handling precautions are needed and the total project will consume over 100mA. So if a rechargeable battery is not being used, constructors should be frugal about how long they leave the meter on!

Because of space the extra functions are not used (but could be if a slightly larger box was used, of course), so pin 3 (function input) is permanently connected to the Do line (pin 4) to make the i.c. function as a frequency counter.

For those who are interested:

- D1 (pin 6) is for frequency ratio
- D3 (pin 7) is for unit counter
- D4 (pin 9) is for time interval
- D7 (pin 12) is for period measurements.

These could be connected to pin 3 via a rotary switch.

The pre-amplifier and prescaler used in the project consists of an amplifier based on the BFY90 (with two diodes to limit the voltage on the base to 0.6V), the base bias set by a preset and the output capacitively coupled to the input of the divide-by-100 prescaler SP8629. This is an i.c. of excellent value, toggling in excess of 200MHz. It will tend to self oscillate in the absence of an incoming signal, but this can be prevented by placing a resistor between pin 6 (the negative edge triggered input) and earth. It provides TTL output and can be coupled direct to the ICM7216B. However there is space on the main p.c.b. for a 74LS132 to be inserted after the SP8629 to provide logic switching, enabling a second input, bypassing the preamp/prescaler, to be fed into the counter. The author found that the circuit worked most reliably when the resistor between 6 and earth is 27k, and the resistor between pin 7 and earth is omitted. Constructors may like to experiment to get the best performance.

It is because the author had already built this module that the project has two p.c.b.s; it saved the bother of designing a master p.c.b. The prototype has the prescaler board mounted in the battery compartment with the battery placed between the two boards. This enabled the switches and sockets to be mounted symmetrically above the prescaler board, being more shallow than the battery, but this necessitated

INTEGRAL PREAMP/PRESCALER

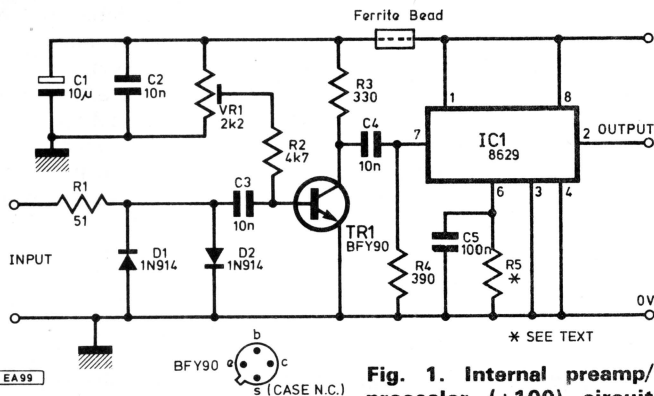


Fig. 1. Internal preamp/prescaler ($\div 100$) circuit diagram

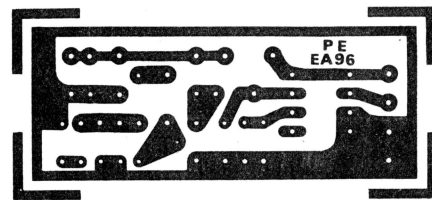


Fig. 2. Internal prescaler p.c.b. design

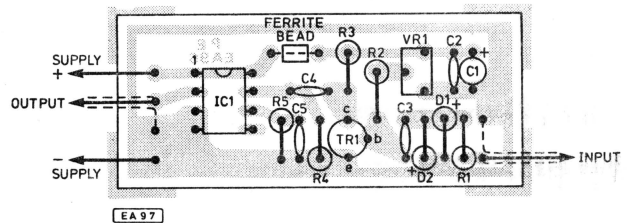


Fig. 3. Component layout

COMPONENTS . . .

INTERNAL PREAMP/PRESCALER

Resistors

R1	51
R2	4k7
R3	330
R4	390
R5	See text

All resistors $\frac{1}{4}$ W 5% carbon

Potentiometers

VR1	2k2 sub. min vertical preset
-----	------------------------------

Capacitors

C1	10 μ tant.
C2, C3, C4	10n ceramic (3 off)
C5	100n ceramic

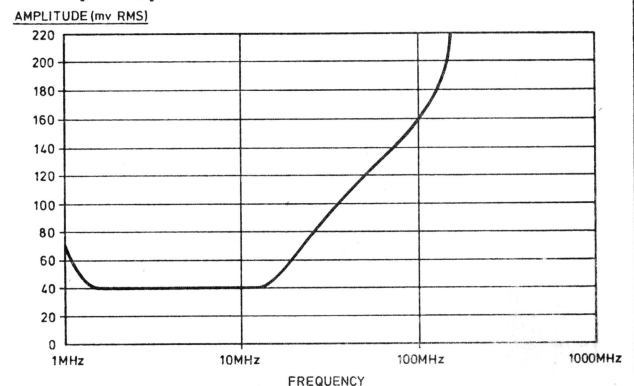
Semiconductors

TR1	BFY 90
D1, D2	1N914 (2 off)
IC1	8629

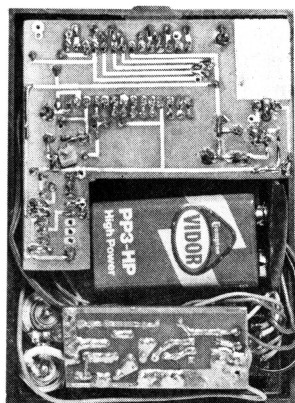
Miscellaneous

Ferrite anti-parasitic bead
p.c.b.
In line circuit module (RS 456-201)

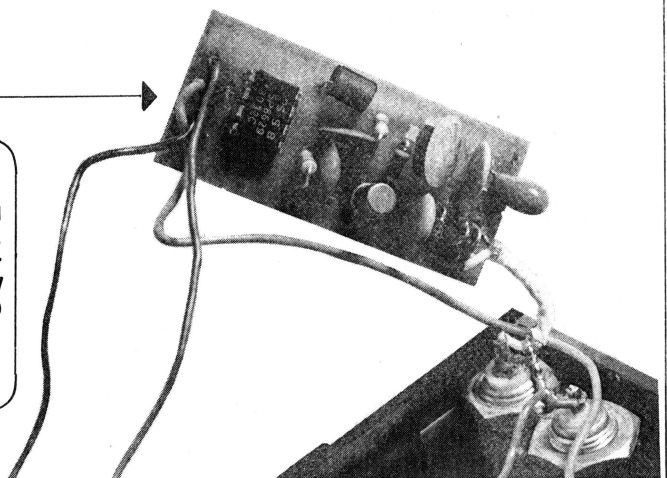
Fig. 4. Response curve of preamplifier/prescaler



EA 98



$\div 100$ prescaler and preamplifier module. This is the prescaler published in *Practical Electronics*, April 1980 issue.



Alignment of the prescaler is simply a matter of setting the d.c. potential at the collector of TR1 to half the supply voltage by varying VR1. The value of R5 is a compromise between open-circuit stability and overall circuit sensitivity.

FREQUENCY COUNTER BOARD

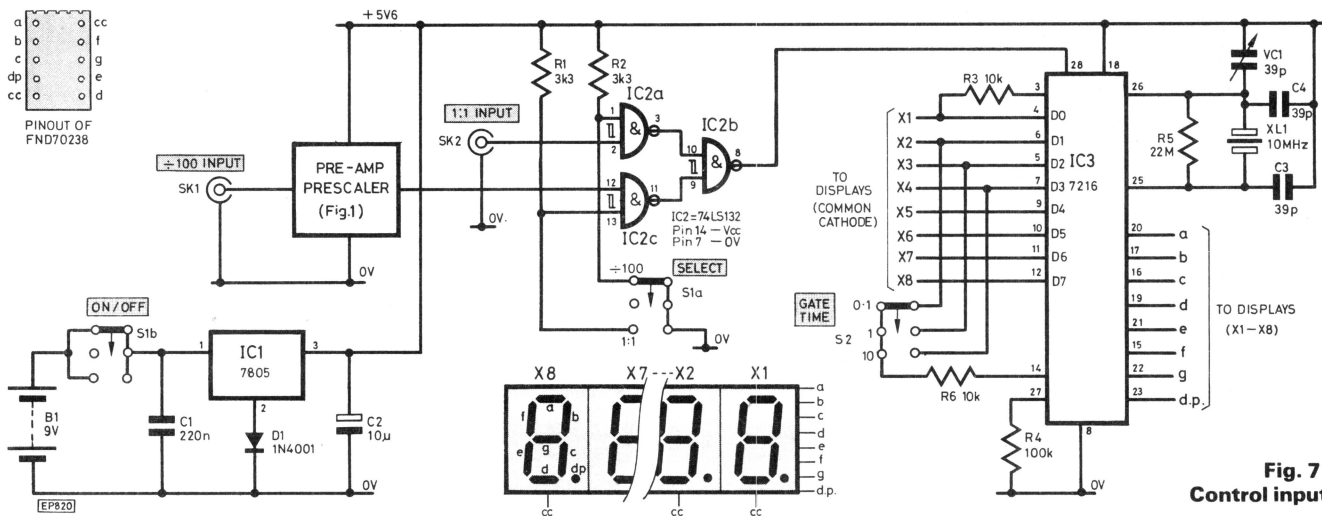


Fig. 5. Overall circuit diagram of frequency meter. Note: The FND70238 display is compatible but obsolete. The FND357 should be used. R5 may be 10M

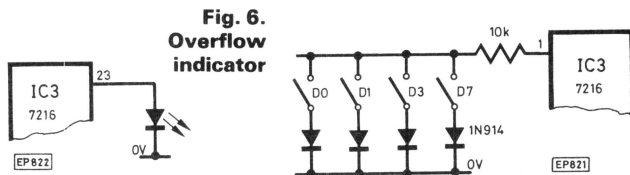


Fig. 6.
Overflow
indicator

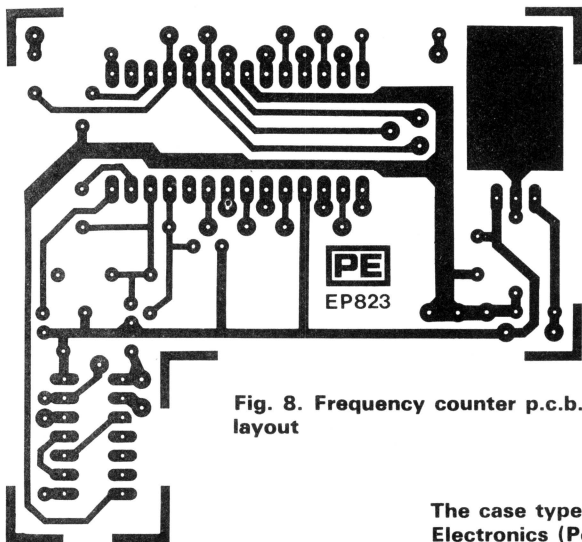


Fig. 8. Frequency counter p.c.b. layout

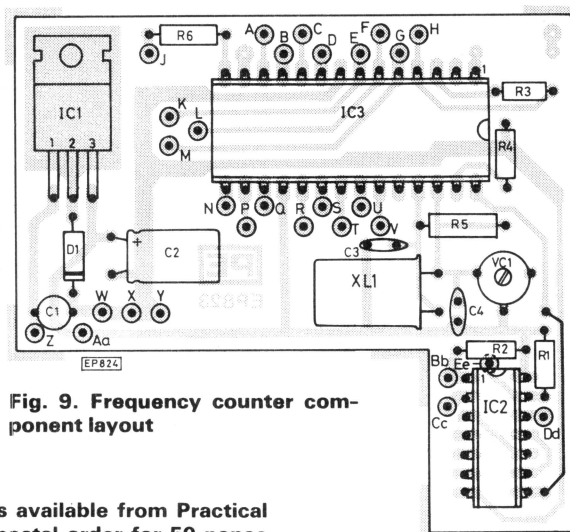
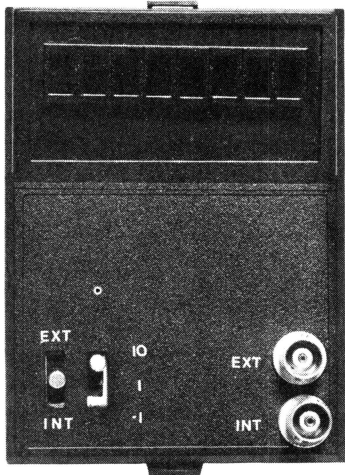


Fig. 9. Frequency counter component layout

The case type shown here is available from Practical Electronics (Poole). Send a postal order for 50 pence to include P&P etc.



COMPONENTS . . .

FREQUENCY COUNTER

Resistors

R1, R2	3k3 (2 off)
R3, R6	10k (2 off)
R4	100k
R5	22M

Capacitors

C1	220n
C2	10μ
VC1	39p

Display

X1-X8 FND357 (8 off)

Integrated Circuits

IC1	7805
IC2	74LS132
IC3	7216B

Miscellaneous

S1, S2 Three position slide switch (2 off)
X1 10MHz crystal
SK1, SK2 50 Ω BNC socket (2 off)
Case
PP3 Battery plus stud connector
Printed circuit board

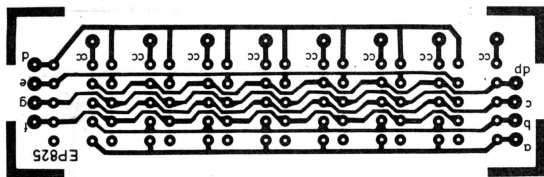


Fig. 10. Display board p.c.b. layout

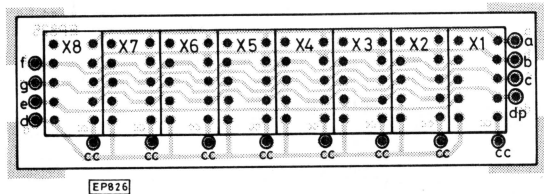


Fig. 11. Component layout. Capacitors need only be soldered on track side

longer lengths of interconnecting wire. Constructors may well decide to place the two boards together, but care will then have to be taken with the switch and socket positions, because of the bulk of the battery.

The output of the SP8629 is connected to pin 12 of IC2, and reference to Fig. 5 will show how it works. Each gate is a two-input nand gate, and the output of this gate is held high when one or other of the inputs is low. So if pin 1 is earthed via S1a, pins 3 (and 10) are high, and because 13 is high (due to R1 pulling it up to supply +ve) it allows frequencies on pin 12 to go through to pins 11 and 9, and then go through to pin 8. If, however, pin 13 is earthed, pins 11 and 9 become high, allowing signals on pin 2 (the spare input), to go through to pin 8, and thence to the 7216B pin 28.

Using a two-pole, three-position slide switch enables this switching function to be linked with an on/off supply switch.

The prescaler drops in performance on, and below 5V, and as the other i.c.s will happily accept a *slightly* higher voltage, the regulator incorporates a silicon diode 1N4001 in the common line. 0.6 volts are dropped across this diode, so the common pin is held at 0.6 volts above zero. The output is regulated at 5V above the common pin, so the output regulated voltage becomes 5.6V.

CONSTRUCTION

This obviously demands care and patience, but is well within the scope of most constructors. The most awkward part of the project is the interwiring of the displays (necessary because the digit outputs are multiplexed). FND357 is the code number of the displays used, and they are approximately 13mm high, containing 10 pins, see Fig. 5 (top left).

The author used normal stripboard, but this involved much track cutting, including breaks between adjacent holes? If the p.c.b. is not used it may well be easier to use plain perforated board, and attach the displays with tiny blobs of glue. The digits would then be wired in parallel, A-A, B-B, etc., except the digit drivers (the common cathode pins), which are connected to the driver terminals D0 to D7, (D0 being the right-hand digit, looking at the display from the front). NB: D1 and D2 are not in order on the i.c. A piece of black plastic was cut to fit behind the aperture in the case, and after a hole was cut in this piece to accept the display (a tight push fit), it was glued behind the aperture. Very short lengths of wire were used to connect the display segments and the digit drivers to the p.c.b. (see wiring diagram Fig. 12). Slide switches (RS code 337-481) and two BNC sockets

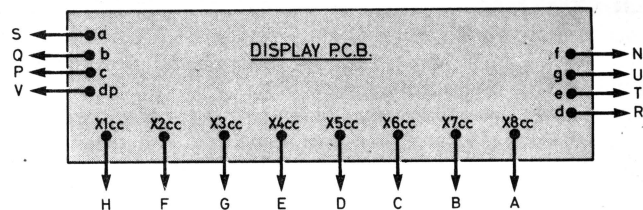


Fig. 12. Point-to-point wiring diagram. Wiring connections to the display board should be made direct to the reverse (copper) side. Wiring at the slide switches will depend on the type used. The d.p. line (V) is not used

were inserted, the switches being attached with glue. Wires were then taken from the D1, D2, and D3 terminals (5,6,7), and connected to one of the slide switches, with the wiper going to the resistor connected to pin 14. This provides the three gate times. The other switch is wired as already shown in Fig. 12 to provide an on/off and input changing.

One BNC is connected to pin 2 of IC2, and the other BNC is connected to the input of the prescaler, using miniature coaxial cable. Connections are taken from the prescaler board for the output, positive and zero to the main board. Make sure that the shields of the BNCs are also connected to zero volts. Depending on where the prescaler board is sited, take care that it does not short on any metal of the battery case, the switches, or the sockets.

ADJUSTMENTS

Measure the output voltage of the regulator to ensure that it is 5.6V. Adjust the preset on the prescaler board to give half this voltage on the collector of TR1.

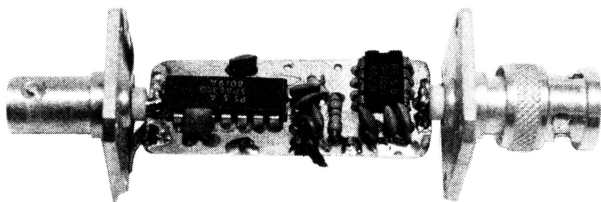
The oscillator needs to be adjusted by means of the trimmer to 10MHz using a reference of some sort. The accuracy of the meter depends on this calibration, and the tolerance of the quartz crystal. VC1 may need to be 65pF.

CONCLUSION

The prototype triggered from a portable rig (one watt) a few feet away, with only a short piece of wire pushed into the BNC socket, and has provided the author with a valuable piece of portable test equipment, registering frequencies up to 220MHz. Some spare pads have been provided should constructors wish to add extras (as well as those mentioned earlier), if they can find the space! Some suggestions are given below.

- 1) If pin 13 is temporarily connected, via a pushbutton, to earth, the counter will reset.
- 2) Pin 1 is the control input, and using IN914 diodes as per Fig 7 digit driver pins can be connected to provide the following amongst others:
 - a) D0 . . . and external oscillator can be fed in
 - b) D1 a 1MHz crystal can be used, using the same multiplex rate
 - c) D3 blanks the display, in conjunction with the hold button, see below
 - d) D7 will test the display, lighting all segments
- 3) If pin 27, normally held low by the resistor, is temporarily connected to +ve the display will hold. If done in conjunction with D3 to pin 1, the display will blank.
- 4) If an l.e.d. is connected between pin 23 and ground, it acts as an overflow indicator (see Fig. 6).

600MHz OPTIONAL PRESCALER



THIS can be built either as illustrated, i.e. an external module housed in a module case (RS 456-201) drawing its supply from two 1mm sockets inserted in the side of the frequency meter case; or as a replacement board for the 200MHz prescaler. Both prescalers will in fact work down to dc level, but below certain frequencies the i.c.s become dependent on the slew rate of the incoming waveforms. The divide-by-ten SP8630 will operate down to 40MHz with a sinusoidal input. The prototype triggered quite happily from the 12MHz oscillator stage of a transmitter using a "sniffer probe" (coaxial cable terminated with two or three turns of 20 SWG wire).

The SP8630 needs to be handled with care, because a negative earth plane is being used and consequently its emitter-follower outputs are liable to damage if shorted to ground, so check the p.c.b. and wiring before inserting the SP8630 and switching on. The output is fed into another divide-by-ten, the much cheaper SP8660 (but which will work at such high frequencies as the SP8630), which provides a TTL compatible output, which goes into the 74LS132 and thence into the counter.

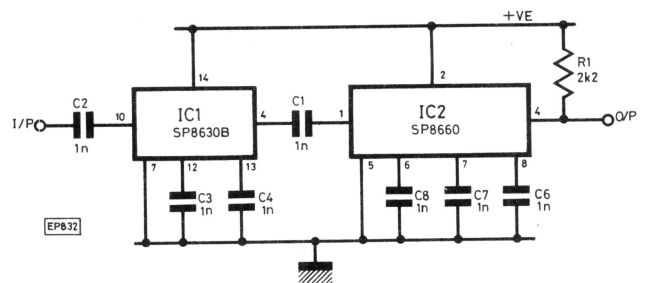


Fig. 13. External/optional prescaler circuit diagram

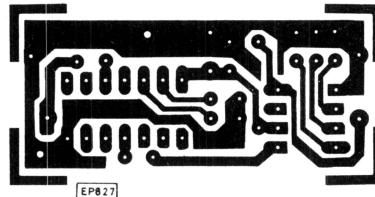


Fig. 14. External/optional prescaler p.c.b. track layout

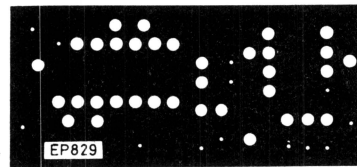


Fig. 15. Component side copper earth plane

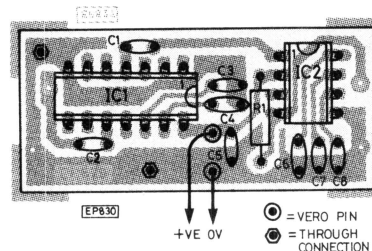


Fig. 16. Component layout

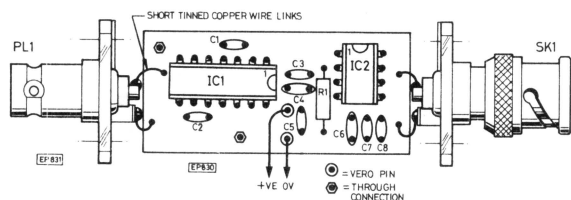


Fig. 17. Connection to BNC connectors

Constructors will no doubt have noticed that there is no preamplifier in the design. This was for two reasons. A preamplifier was designed using a BF180, but to use it precluded the use of the module case, which is an extremely convenient size.

Experiments were then carried out using the prescalers alone, and it was found that using a small pick-up aerial (six inches of wire!) the meter triggered from a 432MHz transmitter feeding 500mW into a helical aerial four feet away. It was felt by the author that this was sensitive enough for most practical purposes. However, it needs to be stated that the input drive level requirements do vary, needing e.g. approximately 80mV peak-to-peak sine wave at 432MHz, but approximately 140mV at 145MHz. The prototype triggered from a 1 watt 145MHz transmitter 6 feet away with ease. For more information constructors are advised to consult the Plessey data contained in their publication *Digital Integrated Circuit Data Book*, and if necessary build a preamplifier from the many designs available, knowing that a bigger case will have to be used.

The second reason is that the battery drain, already high, would have been unacceptable had a preamplifier been included in the circuit.

CONSTRUCTION

It has been stated from the outset that constructors have a clear choice whether to build this prescaler into the meter, or as an external module. The former method is simply a matter of filling the 200MHz space with the 600MHz board, using the same supply and input/output leads. The meter will then still have a spare input. To use the prescaler externally, the RS module box has first to be slightly modified. Cut back the centre contacts of the sockets inside the box as far as possible, and drill a small hole in the side of the box, through which the supply leads can be fed.

The project uses a double sided printed circuit board, the component side being used as an earth plane, and if constructors attempt their own, it is not difficult. Prepare the track side as normal, using an etch resist pen or transfers, and then cover the reverse side with either etch resist or, as the author does, with insulating tape, using a slightly oversized board, and folding the tape slightly over the edges to prevent seepage of the Ferric Chloride. After etching, cut and file the board down to size, and drill the holes out as normal. Then from the component side countersink all non-earth holes, hand-twisting a $\frac{1}{8}$ inch drill bit, or using a Veroboard cutter. The author also drilled three or four holes through the board where there was earth both sides to ensure the earth planes were connected together to counteract possible capacitance problems.

The components are then mounted close to the board (without shorting the earth-plane) and components going to earth are soldered both sides. It is always a wise policy to use double-sided board at these sorts of frequencies, but the author did make a single sided board, using exactly the same design minus the earth-plane, and it did work as an external module, but this may be a fluke of the particular i.c.s and may not be repeatable.

Two pieces of copper wire were inserted into the input and output positions on the board, and these were soldered direct to the centre contacts, thus suspending the board inside the case. This ensured that the board did not short out on the metal case. The case earth contacts were then bent over and soldered direct to the board, and the supply leads were fed through the drilled hole. Refer to Fig. 17 which should make the explanation clearer. After a careful check replace the removable side of the case and bolt the module together.

COMPONENTS . . .

Resistors

R1 2k2

Capacitors

C1-C8 1n (8 off)

Integrated Circuits

IC1 SP8630B

IC2 SP8660

Miscellaneous

Printed circuit board
BNC plug and socket

Two 1mm sockets need to be inserted into the side of the frequency meter case, one connected to earth, the other to the output of the voltage regulator (5V6). Two 1mm plugs are connected to the supply leads of the prescaler module. The INT/EXT switch should be set to EXT, the module connected to the EXT BNC socket and a small pickup aerial attached. The author cannibalised a small transistor radio telescopic aerial (about 6 inch, long unextended), and soldered it to the centre of a BNC plug. Epoxy resin sealed the unit and prevented the aerial from shorting on the BNC plug case. The meter should then read frequencies up to 600MHz.

If constructors are irritated by the display counting randomly, caused by the SP8630 and the SP8660 self oscillating, a cure can easily be effected using the following procedure: (however this will cause a *slight* loss of sensitivity). Solder a 15k resistor between the input, pin 10 of the SP8630, and earth (on the track side if necessary), and a 39k resistor between pin 8 of the SP8660 and earth.

CONCLUSION

It is hoped that this article will enable constructors to build what has proved to the author to be a very useful piece of portable test equipment, e.g. for testing portable rigs, radio control transmitters (27MHz, 35MHz, and UHF) at a price and performance to beat most commercial units. ★

BAZAAR

WANTED 1L30 Plug-in unit to suite tektronix 585A oscilloscope to convert to spectrum analyser. David Baker, 7 Iona Close, Sinfon Moor, Derby. Tel: 769334.

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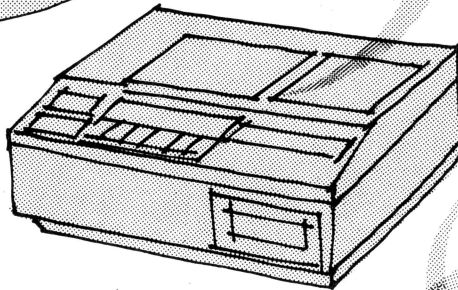
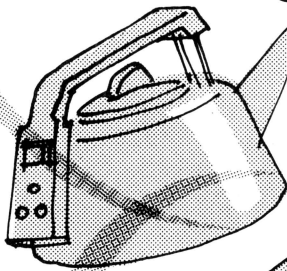
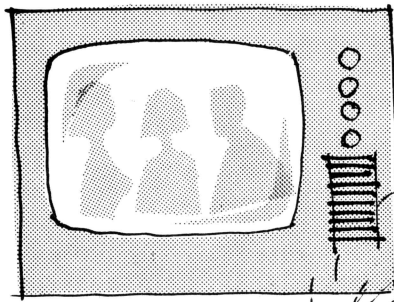
PRACTICAL ELECTRONICS

JUNE ISSUE ON SALE FRIDAY, MAY 14th

PROGRAMMABLE TIMER/CONTROLLER

T.J. JOHNSON

PART ONE



indicate whether it is AM or PM, and also the day of the week (Sunday to Saturday). The time and day are initially set via the keyboard, and once in operation depends on the accuracy of the mains 50Hz frequency for its overall accuracy.

TIMER/CONTROLLER

Used as a programmable timer controller, the i.c. can retain in its memory up to 18 separate pre-programmed "timer sets", which are entered via the keyboard. Each timer set can control one of four switches, which in turn control an external appliance. Only two states are possible, either on or off.

The timer sets can be placed into three modes:

1. *Fixed Time Programs*, which will turn on or off a particular switch at a particular time.
2. *Interval Programs*, which will turn on or off a particular switch after a specific time interval has elapsed from the time the program was entered.

Once executed, an interval program is erased from the memory, thus these types of programs can only be executed once. Fixed time programs however, are retained in the memory and are executed repeatedly.

THIS article describes a programmable timer/digital clock which has the ability to control mains operated appliances. Basically the unit consists of a conventional digital clock which displays the time of day in the 12 hour format, either AM or PM and also the day of the week.

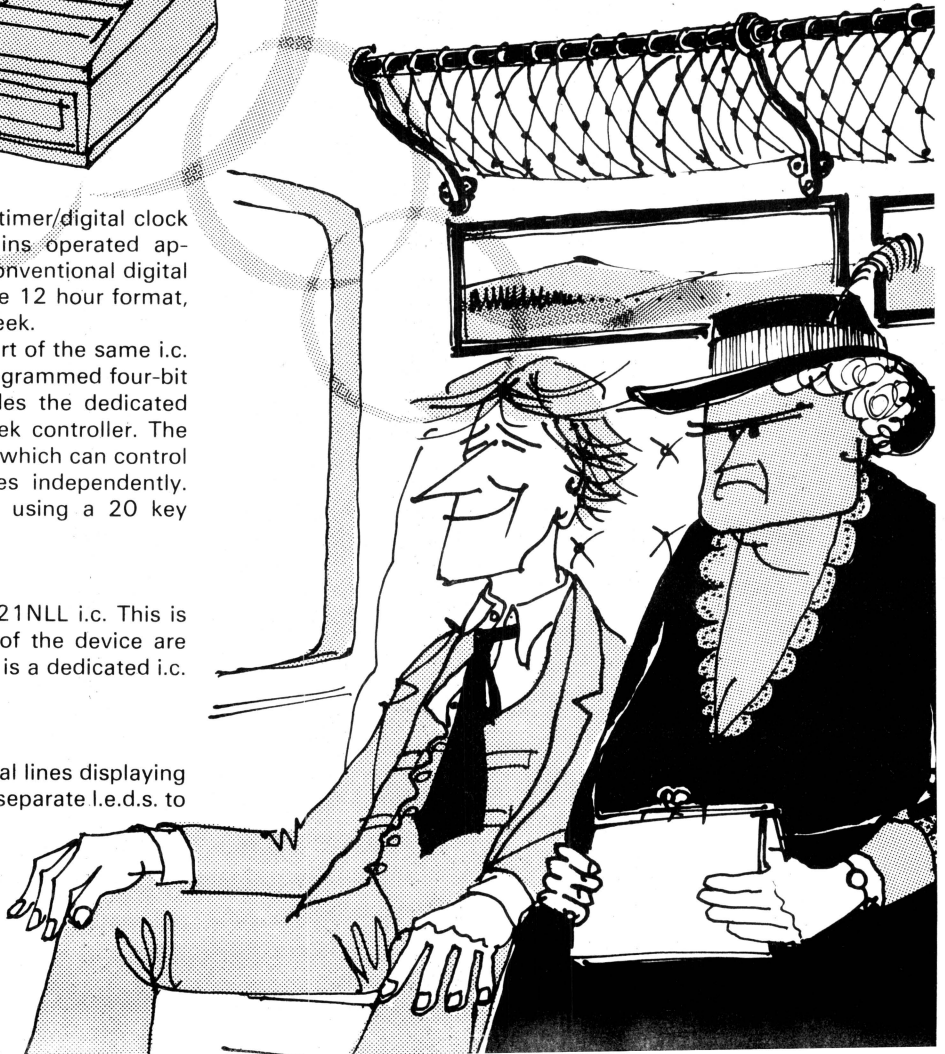
The timer/controller section (actually part of the same i.c. used by the clock), is a specially mask-programmed four-bit single chip micro-computer which provides the dedicated function of a time of day and day of week controller. The system provides a total of 18 "timer sets" which can control any one of four mains operated switches independently. Programming the system is very simple using a 20 key keyboard.

THE TMS1121NLL I.C.

The basis of the system is the TMS1121NLL i.c. This is housed in a 28 pin package and details of the device are shown in Fig. 1. As mentioned above, this is a dedicated i.c. and has the following important features.

CLOCK OPERATION

Operation as a clock follows conventional lines displaying the time in the usual 12 hour format, with separate l.e.d.s. to



3. Sleep Programs. A special function on the keyboard is the SLP (sleep) key. If this key is used after an interval program, then that switch to which it applies is turned on immediately and then turned off exactly one hour later. Using this function a valuable timer set can be saved for some other application.

OTHER FUNCTIONS

The i.c. via the keyboard can provide direct operation of any of the switches without programming that function into the memory. Thus any switch can be turned on or off independently of any program relating to that switch—a particularly useful function.

The timer *sets* can be changed at any time by either selectively erasing the *sets* which relate to a particular switch or to a particular day, or by erasing all the *sets* and starting fresh with a clear memory.

Finally, any program in the memory can be recalled using the keyboard, the state of the program being displayed by i.e.d.s. The standard four digit clock display is used to show the time at which the switch is to be turned on or off, while various other i.e.d.s. indicate the day of the week, the switch number, either AM or PM and whether the switch will be on or off at that time.

CIRCUIT DESCRIPTION

The complete circuit for the Programmable Timer/Controller is shown in Fig. 2.

The circuit requires two voltages which are obtained from the mains power supply. The first supply is obtained by rectifying the a.c. output from the 9V mains transformer to give about 12V d.c. This is used for the display segments and also the i.e.d.s.

The second supply uses an 8V regulator to provide a stable and fully regulated output of 9V. The precise voltage may be varied by using the preset VR1. This supply is used to power the main i.c. and the interface i.c., IC3. As well as providing the two voltages the mains transformer also supplies a source of 50Hz, which is used as the standard clock signal for the microprocessor IC2.

The i.c. operates at a frequency of approximately 300kHz, this frequency being set by the values of C7 and R3. The 50Hz clock signal from the mains transformer is applied via TR1, which roughly squares the sine wave, to the input at pin 8. Transistor, TR2 and associated components, use the 50Hz signal to provide a short pulse which is used to reset the internal circuits and to clear all information in the memory when the timer is first switched on.

KEYBOARD

Information to be programmed into the i.c. is input via the keyboard of which a few of the keys have double functions, for example the E DAY/O key is the numeral "0", and the events key to program what happens on each of the seven days of the week.

The switch numbers and their functions (and also the front panel labelling) are shown in Table 1.

SWITCHES

The circuit provides for turning four relays on or off, via TR12 to TR15 and their associated resistors. Obviously, other output devices may be used, s.c.r.s. for example could be driven by the transistors, but for simplicity and maintenance free operation, relays would appear to be the most appropriate choice. The outputs from the relays are connected to four mains sockets.

Switch number	Function	Labelling (for front panel)
1	Everyday or numeral 0	E DAY 0
2	Sunday or numeral 1	SUN 1
3	Monday or numeral 2	MON 2
4	Tuesday or numeral 3	TUE 3
5	Wednesday or numeral 4	WED 4
6	Thursday or numeral 5	THU 5
7	Friday or numeral 6	FRI 6
8	Saturday or numeral 7	SAT 7
9	Numeral 8	8
10	Numeral 9	9
11	AM setting	AM
12	PM setting	PM
13	Set day of week or display day of week. (Press twice to display).	WK DISP
14	Set switch number or display switch (Press twice to display).	SW DISP
15	Set switch ON	ON
16	Set switch OFF	OFF
17	Set SLEEP function	SLP
18	Clear last entry or correct error	CLR
19	Clear all programs from memory	CM
20	Start clock (only used when changing time setting on clock).	CLK

Table 1. Switch numbering and their functions

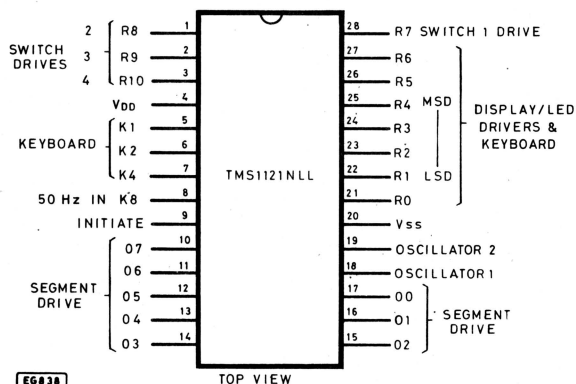
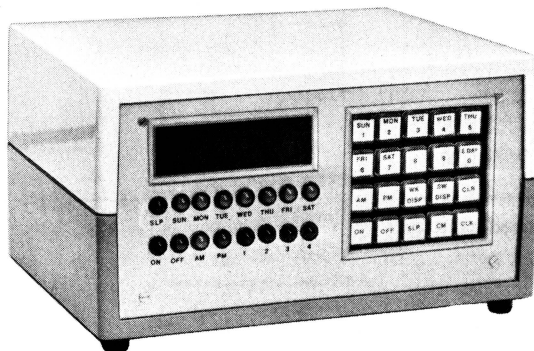
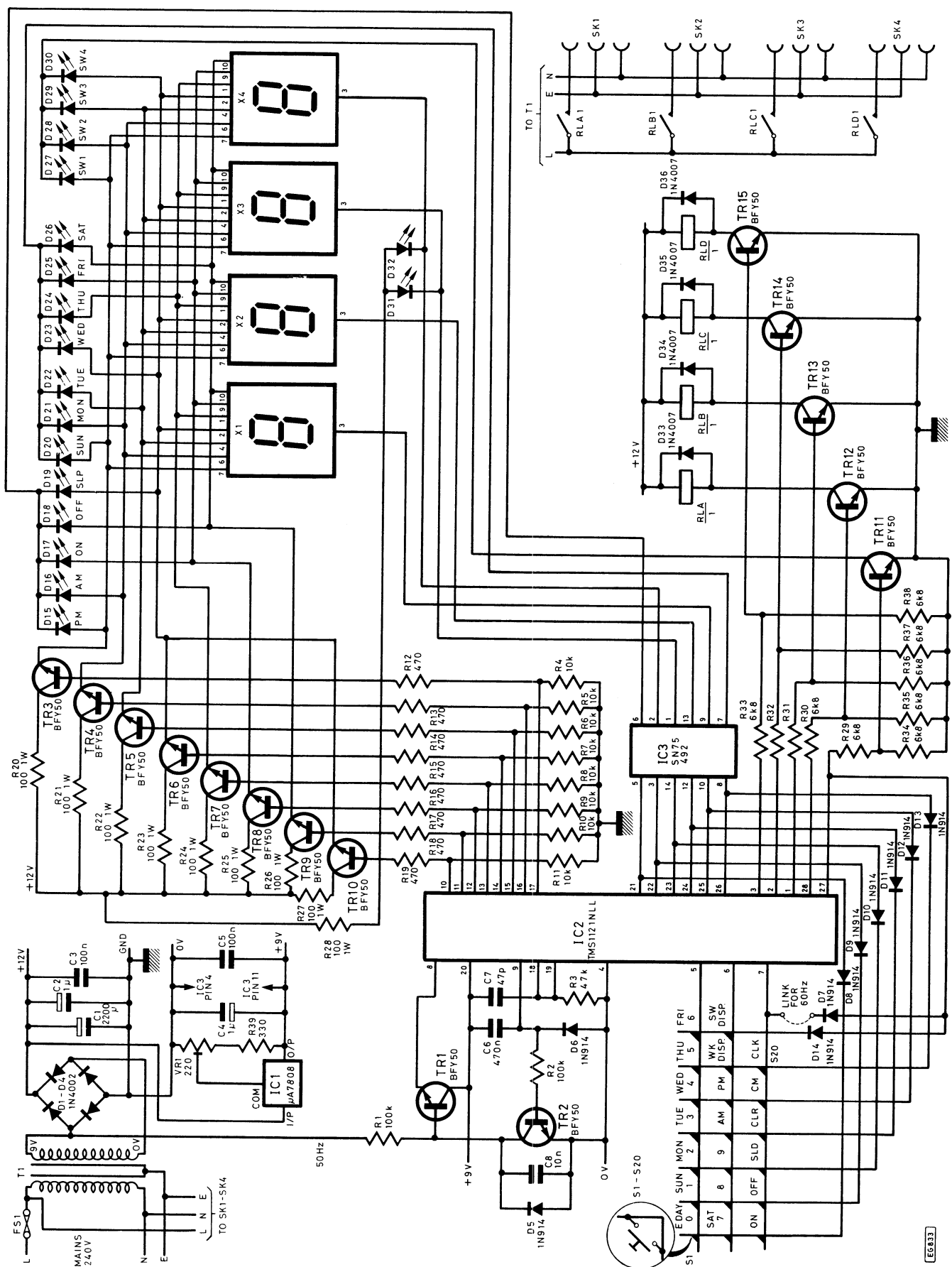


Fig. 1. The TM5 1121 NLL





COMPONENTS . . .

Resistors

R1, R2	100k (2 off)
R3	47k
R4-R11	10k (8 off)
R12-R19	470 (8 off)
R20-R28	100 1W (9 off)
R29-R38	6k8 (10 off)
R39	330
VR1 220 hor. preset	
All $\frac{1}{4}$ W 5% except where stated	

Capacitors

C1	2200 μ 25V elect
C2	1 μ 63V elect.
C3, C5	100n polyester (2 off)
C4	1 μ 63V elect.
C6	470n polyester
C7	47pF polystyrene or ceramic plate
C8	10n polyester

Semiconductors

D1-D4	IN4002 (4 off)
D5-D14	IN914 (10 off)
D15, D18	0.2in l.e.d. green (2 off)
D16, D20-D26	0.2in l.e.d. yellow (8 off)
D17, D19, D27-D30	0.2in l.e.d. red (6 off)
D31, D32	0.125 in l.e.d. red (2 off)

D33-D36
TR1-TR15
IC1
IC2
IC3
X1-X4

IN4007 (4 off)
BFY 50 (15 off)
 μ A 7808
TMS 1121 NLL
SN 75492
0.6" 7 segment display red.
TIL322 or FND500 (4 off)

Switches

S1-S20 miniature keyboard switch with removable cap. (Ambit type ref. KHC10901—switch, two part cap type KT5 ref. 53-90901).

Relays

RLA-D OUD type. s.p.d.t. contact, 12V 400 ohm coil. (Maplin type ref. YX97F). Other types with a similar coil may be used, but may not fit the p.c.b.

Miscellaneous

T1 9V 1A mains transformer
SK1-4 "Euro" type 3 pin mains socket rated at 240V 6A.
Heatsink for IC1
Small mounting brackets (4 off)
6BA hardware
I.c. sockets if required, FS1 13A fuse and fuseholder
Three p.c.b.s
Verobox type 21036G 205x140x110mm
Piece of red perspex
Plastic trim
Mains cable connecting wire etc

DISPLAY INTERFACE

The hours/minutes display uses four 7-segment displays which are multiplexed, the segments being driven via TR3-TR9 and associated resistors R12-R18 and R4-R10. Current limiting of the segments is provided by resistors R20-R26, and as they are multiplexed the average segment current is 10mA.

The multiplexed drive for each of the four displays is provided by the interface i.c., IC3. This is a special MOS to l.e.d. digit driver, and is required to provide the necessary interface between the very low level MOS output from the i.c. to the high current drive requirements of the displays.

The remaining three outputs of the i.c. are used to drive the indicating l.e.d.s D15-D30. These l.e.d.s are also multiplexed and share the drive on the segment lines.

The clock normally operates at 50Hz, however, if it is to be used where the mains frequency is 60Hz, then the link indicated must be fitted.

CONSTRUCTION

Construction is quite straight forward, the vast majority of the components being mounted on three printed circuit boards. The type of housing used for the project was chosen because it was the most practical type to use, some constructors may like to house the project in a more aesthetically pleasing case, with just say, the four digit display on the front panel and perhaps the keyboard mounted on the top or side. It should be quite easy to split the display/keyboard p.c.b. in two and mount each in a suitable position.

Personal preference also applies to the choice of output connectors, obviously a universal method of connecting the appliances to the unit was required. The first choice was conventional 3 pin flat sockets, however this would have made the dimensions of the case rather large. The second choice was to connect the various appliances directly and

permanently to the unit. This would have meant that the unit could not be used with additional appliances without considerable work to change each one over. Of course this direct method can be used where it is envisaged that future changes are not required.

The system adopted was the use of "Euro" type sockets as shown. Each mating plug was connected to an appropriate length of three core mains cable, the opposite end being fitted with a rubber line socket, the type found on electric drill extension leads. The length of each lead will of course depend on the distance of the unit from each appliance, so a central position should be chosen and the length of each lead adjusted accordingly. All of the four leads need not be made up at the same time each one being wired up when they are required.

PRINTED CIRCUIT BOARDS

There are three p.c.b.s; the display/keyboard, main logic and driver board, and the power/relay board.

The p.c.b. design for the display keyboard is shown in Fig. 3 with the component layout shown in Fig. 4. The key switches can be mounted first, remember that only the types specified will fit onto the board. They may be orientated either way. The four 7-segment displays and the two l.e.d.s. which fit between two of the displays can be mounted next. Do not mount the remaining l.e.d.s. at this stage, they will be fitted later.

The design and component layout for the logic/driver board are shown in Figs. 5 & 6. A socket is advised when mounting the main i.c. and the interface i.c. For neatness the transistors were mounted on nylon mounting pads, although this is not essential. The 1W resistors should be mounted just above the p.c.b. as they get slightly warm in operation.

If the system is to be used on 60Hz mains operation then the link indicated should be wired in, it should be left unconnected when used on 50Hz.

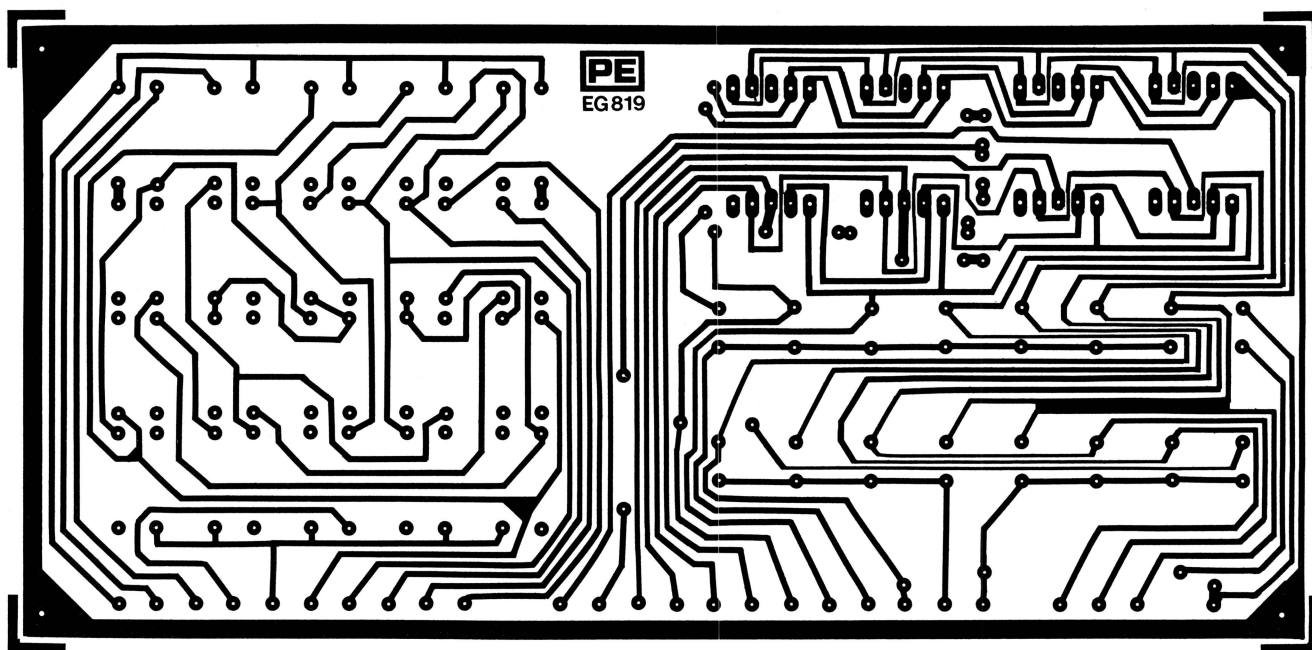


Fig. 3. P.c.b. design for the display keyboard

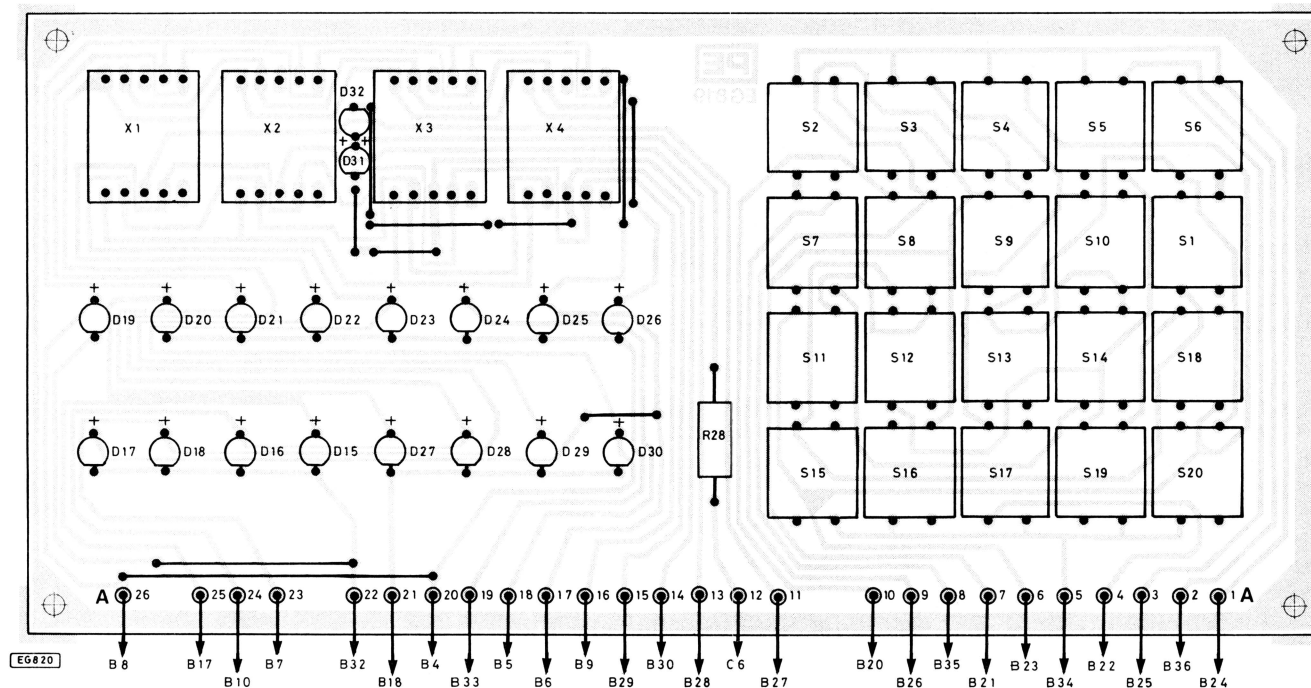


Fig. 4. Component layout

The power supply/relay board is the last to be completed and the design and component layout are shown in Figs. 7 & 8.

DRILLING DETAILS

Cutting details for the front panel are shown in Fig. 9. These dimensions are exact and should not need variation. The two large cutouts were finished off with lengths of special plastic edging, although a similar effect can be achieved with p.v.c. sleeving. A piece of red perspex was

glued in place as shown on the photographs.

Standard two piece plastic i.e.d. clips were pushed into each of the holes but the retaining rings were not fitted at this stage.

The cutting details for the rear panel are shown in Fig. 10. The sockets are a push fit so the cut-outs should be as accurate as possible and can even be a little undersize.

The key switches come with a two part cap, and lettering can either be applied to the bottom half directly, or on small squares of white paper.

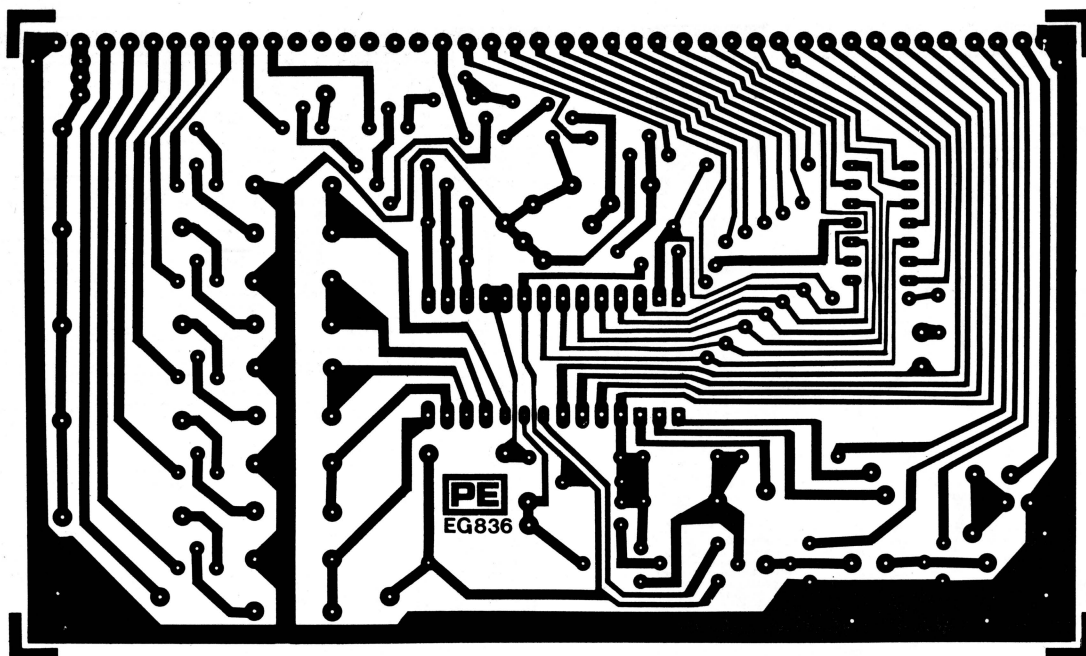


Fig. 5. P.c.b. design for the logic driver board

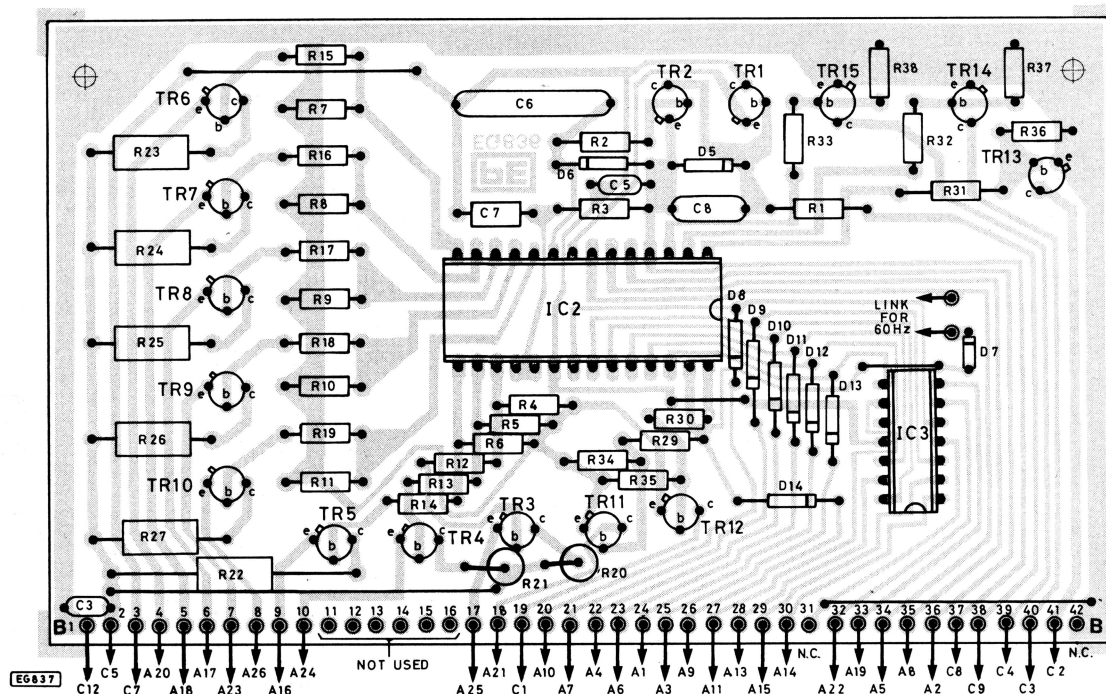


Fig. 6. Component layout

FINAL WIRING

The display/keyboard p.c.b. should first be mounted on the front panel. Before doing so, connect all the flying leads to the board. Each wire can be about 6-8" in length, ribbon cable can be used here, but note that each connection on the display board is not in sequence with the same connection on the logic board.

Next mount all the I.e.d.s. into their panel clips and push the locking rings over each clip. Note we are using three different coloured I.e.d.s. so be sure to insert each into their correct place. Two methods can now be used to connect the

I.e.d.s to their respective connection on the p.c.b. Either use short lengths of connecting wire, say 2", and connect each lead of the I.e.d.s to the p.c.b., or, as in the prototype push the leads of the I.e.d.s. directly into the correct holes. If this method is used then the leads will need to be splayed out slightly. This operation is quite difficult and inexperienced constructors should use the first method.

Finally, using spacers and countersunk screws the p.c.b. can be permanently fitted into position.

The mains outlet sockets can now be mounted on the rear panel, if they seem a little loose then they may be fitted in

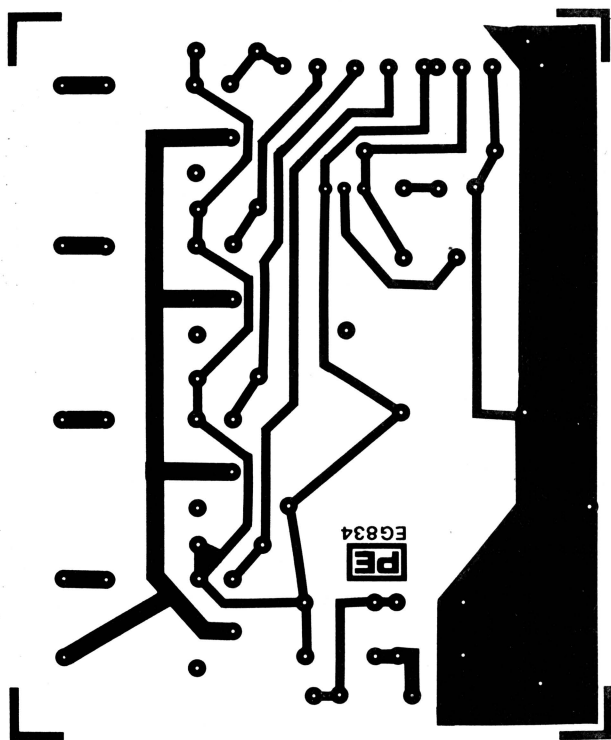


Fig. 7. P.c.b. design for the p.s.u.

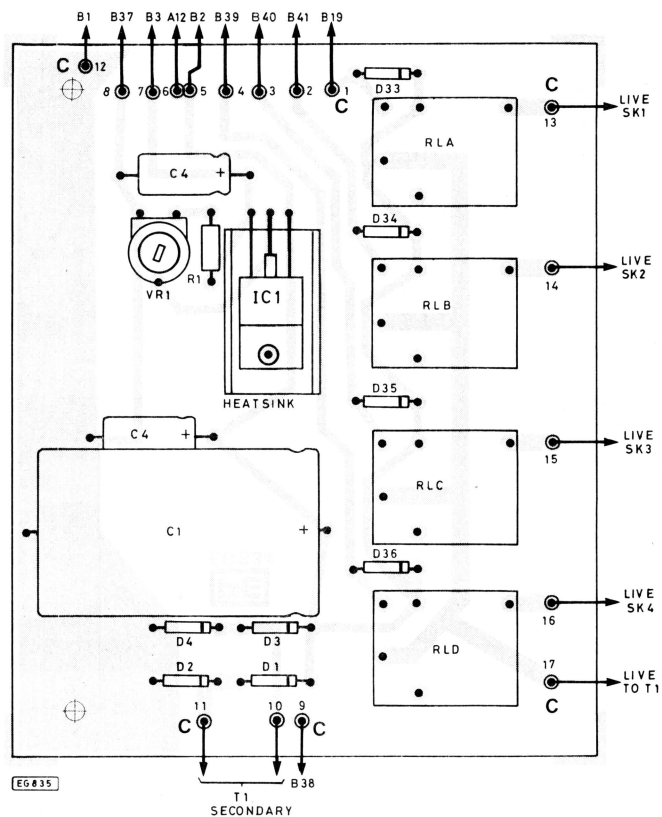


Fig. 8. Component layout

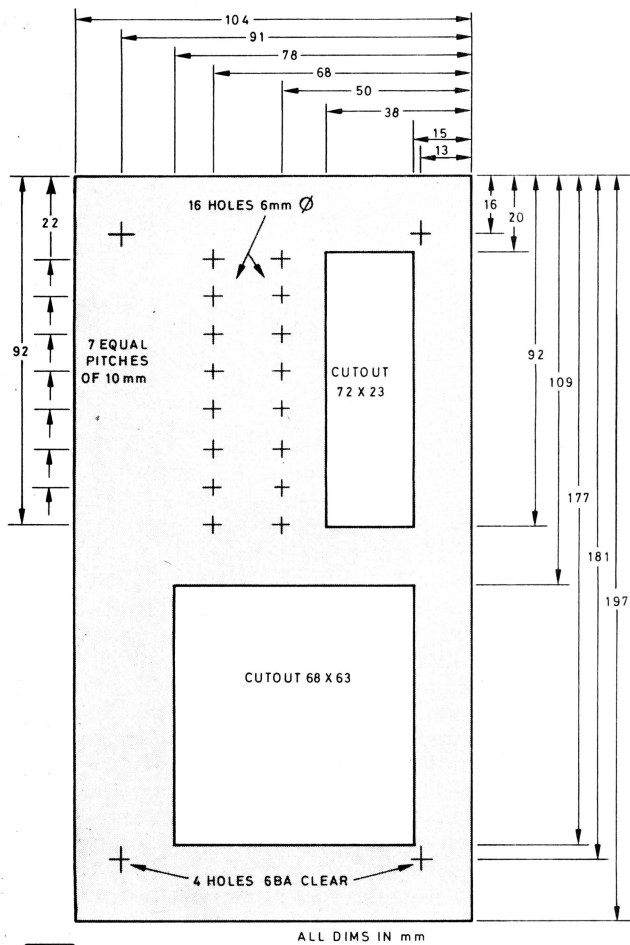


Fig. 9. Cutting details for the front panel

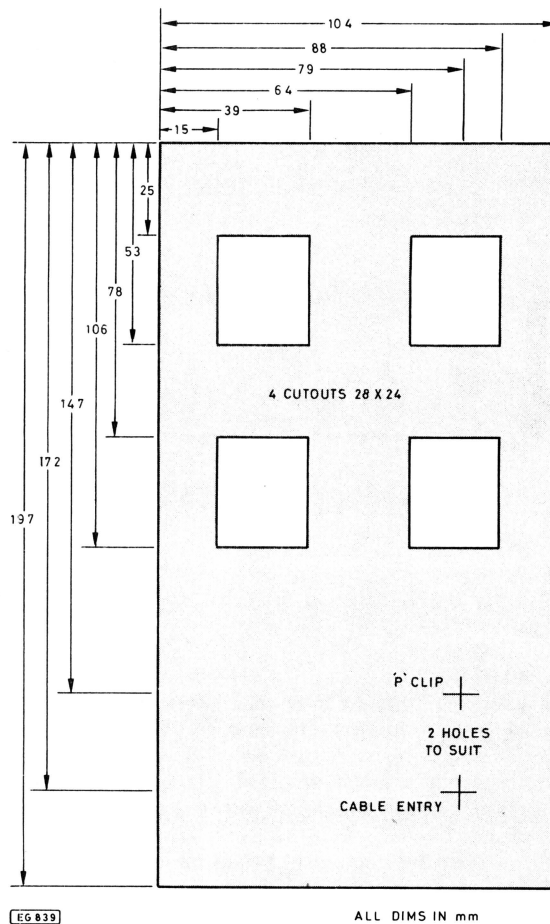


Fig. 10. Cutting details for the rear panel

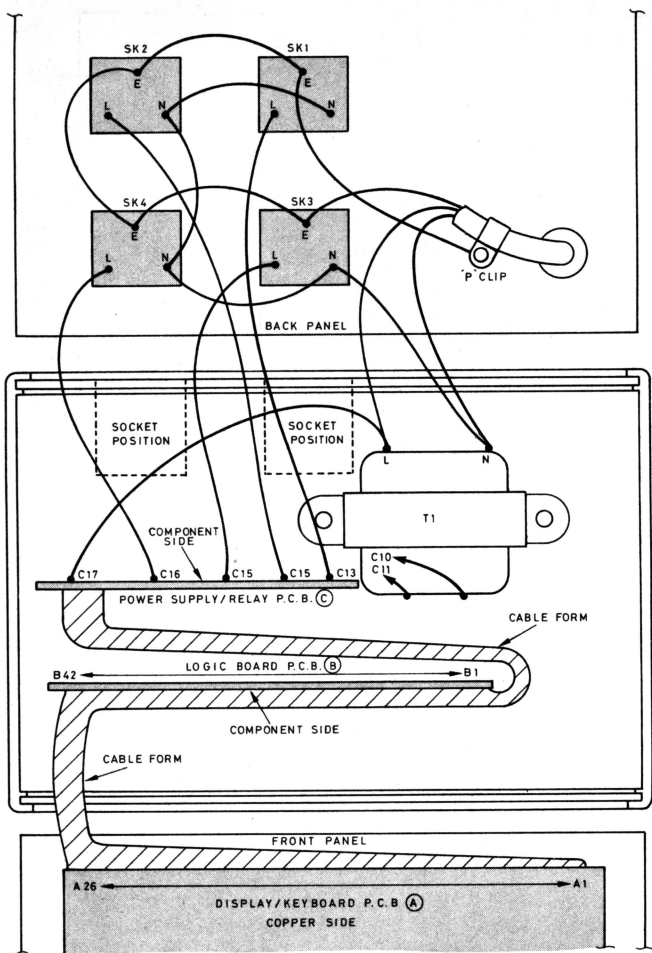
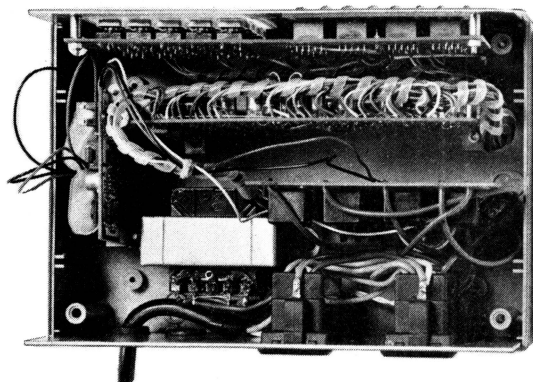
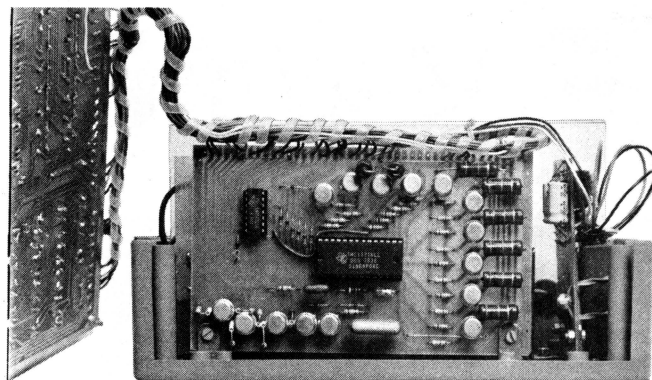


Fig. 11. Wiring diagram



Internal views

place with a strong adhesive if required. The remaining two p.c.b.s. can be mounted in positions as dictated by the dimensions of the transformer. Small right-angled brackets can be used to mount the boards.

Finally, the remaining wiring shown in Fig. 11. can be completed.

TESTING

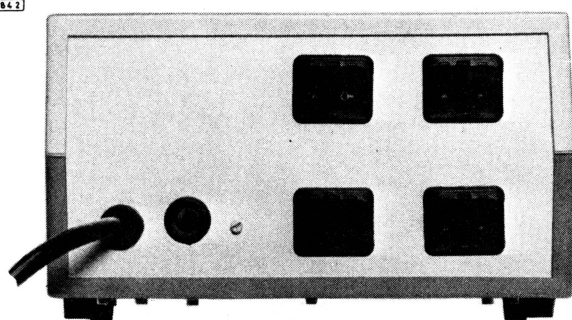
Before connecting the unit to the mains, the p.c.b.s. should be checked for errors, solder splashes, bridged tracks etc. If all seems well, temporarily remove the leads going to the 12V and 9V connections on the power supply board. Connect the unit to the mains supply. **BE VERY CAREFUL** when working on the power supply/relay board, it carries mains voltage as soon as the mains supply is connected.

With a voltmeter check the 12V supply, it should within reason, be 12.5V, anything greater than this there is most likely a fault and should be rectified before continuing. Next measure the 9V supply and adjust the preset to obtain precisely 9V. Do this as accurately as possible, as the main i.c. is rather critical about the voltage applied to it.

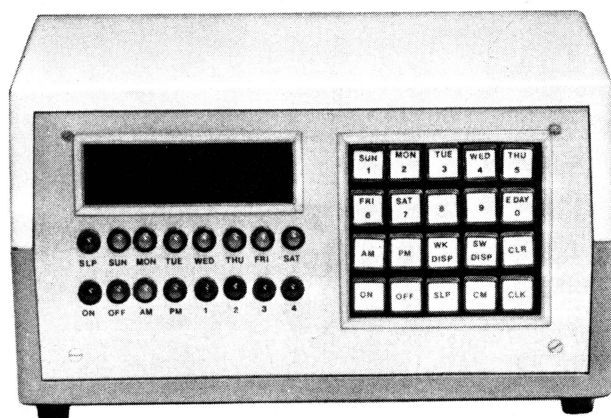
If all is well, reconnect the two supply leads, switching off the mains supply first of course. Next reconnect the mains supply and observe that the display illuminates and shows 12:00, with the PM and Sunday i.e.d.s. lit only when the CLK key is pressed. If the unit is connected to 60Hz mains frequency then the display will show real time and continue to change as each minute passes.

There are no further tests to be made, and the unit can be left connected to the mains to insure that no component overheats. The large 1W resistors will of course get warm but should be of no concern.

NEXT MONTH: Battery back up and programming.



Rear panel



Front panel layout

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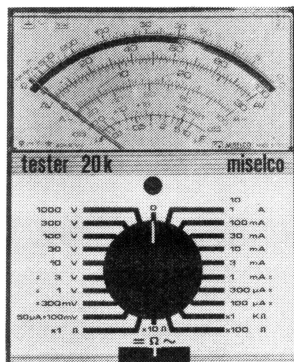
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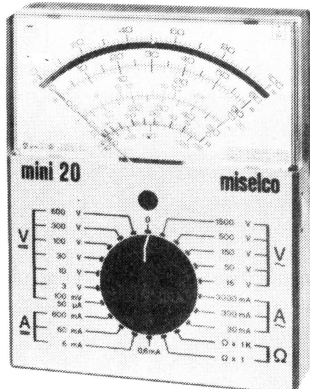


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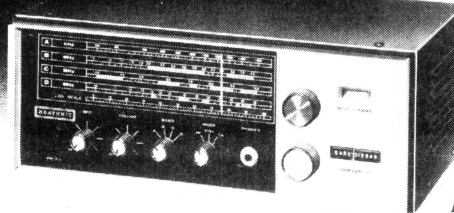
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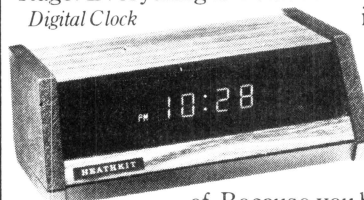
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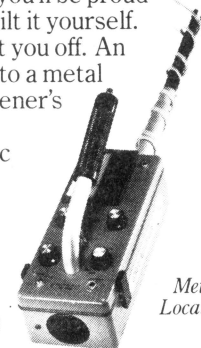


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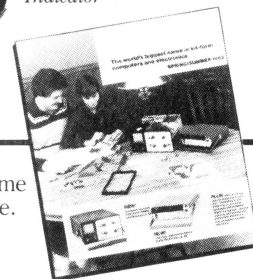
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IEEE-488/IEC-625 INTERFACE BUS & Automatic Test Equipment...

By D. Mandelzweig

INTERESTED in microcomputers for business and at home? Would you like to expand your system, easily, with a truly standard bus? Do you take tedious measurements? Then maybe the IEEE-488 bus and its applications which is the subject of this supplement will interest you. Even if you do not own or use a mini- or microcomputer, but are interested in test instrumentation and Automatic Test Equipment (ATE) and its uses, read on.

MICROCOMPUTERS are already in widespread use in small businesses, keeping full control of accounts, debtors, creditors, stock etc. However, few people are aware of the tremendous capabilities these computers have in the electronic workshop, especially in small companies where items are manufactured and have to be tested, or where repetitive test work is to be done.

For the amateur at home, the IEEE 488 bus allows easy interfacing of sophisticated (if required!) devices for the home computer. Not only sophisticated devices, but also printers, plotters, floppies and hard disks. Readily available LSI IC's are available with full application notes, allowing the experimenter to interface anything he desires with his own computer.

It is the intention of this supplement to give an insight into small and large scale automatic testing, a glimpse of what 488-bus devices are available, and an introduction to the mode of operation of the bus, according to the standard.

INTRODUCTION AND HISTORY

The IEEE-488 INSTRUMENTATION BUS (called the 488-bus or just the bus in the rest of this feature) was originally designed and developed by Hewlett Packard (HP), who still hold world wide patent rights on the bus. It was designed by them "to provide an effective communication link over which messages are carried in an unambiguous way among a group of interconnected devices" (Ref 1). The method uses a 3-wire handshake to transmit bit-parallel, byte-serial data, which can be divided into two broad categories, viz:

- (i) messages used to control the interface system itself, referred to as interface messages, and
- (ii) messages used by the devices connected to the bus, referred to as device dependant messages.

In 1975 the IEEE adopted this HPIB (Hewlett Packard Interface Bus, or GPIB—General Purpose Interface Bus by which it is also well known) as a standard for bit-parallel, byte-serial data transmission, mainly intended for use in instrumentation systems. In 1978 the standard was slightly improved, and was rewritten to make it more understandable. The standard has an international counterpart, the IEC-625, which differs mainly in the hardware connector implementation.

WHERE IS THE BUS USED?—ATEs

Let us consider a small illustration in the use of the bus to introduce the ATE concept, and the bus application. Although one could argue that the example to be presented can easily be achieved manually, consider the full implications of the idea given in the example, the advantages gained, and remember, it's only an example.

Consider the manufacturer of small d.c. motors, each motor having to be tested before leaving the factory. The parameters to be measured are winding resistance, run up time, and run current. The instrumentation required is a counter-timer (C/T) a digital multimeter (DMM), a tachometer and a d.c. power supply. The manual method of testing needs no explanation, except to say that a stop-watch would probably be used instead of the C/T. Let us assume that the equipment is connected as shown in Fig. 1, where the switching matrix (consider it as a "black box" for the meantime) connects the Unit Under Test (UUT) to the instrumentation as shown in Figs. 2a and 2b depending on the test being conducted.

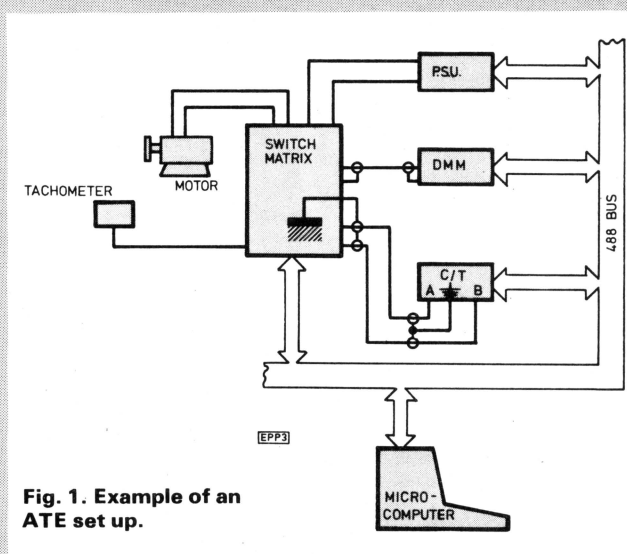


Fig. 1. Example of an ATE set up.

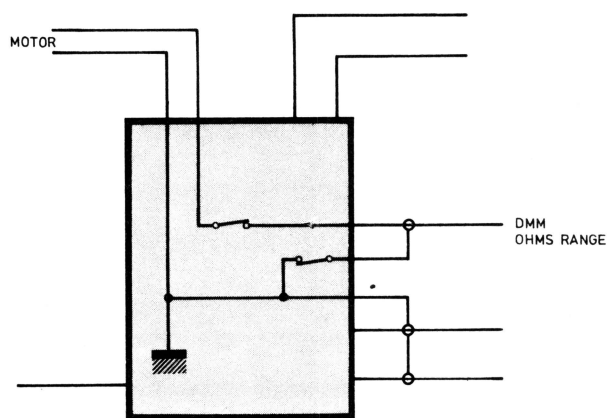


Fig. 2a. Coil resistance measurement

The procedure is as follows. On switch on, the computer asks the operator to enter his name, the date, and UUT serial number. The computer prompts the operator to connect the UUT to the jig and, when ready, to hit the RETURN key. Via the bus, the computer will put the DMM into Ohms mode, select the range and configure the switching matrix in Fig. 2a. When the DMM has measured the coil resistance, it will transmit the value back to the computer. The computer then changes the DMM mode to A d.c., programs the power supply for the required drive voltage (this could be read and checked by the DMM as an intermediate step) and configures the switching matrix as in Fig. 2b. The C/T is set up in its time interval mode, which simply measures the time taken between two positive pulses appearing at its A channel and B channel respectively. When this has been done, the switches S1 and S2 (Fig. 2b) are closed simultaneously, applying power to the motor, and starting the timing process.

The computer sits waiting for the C/T to finish its measurement and send it back to the computer. The pulse that stops the time measurement is derived from the tachometer, which has been specially designed (the only non-bus instrument) to produce a pulse when the required running speed has been reached. Since the motor is now at speed (the computer has received the run-up time) the computer uses an interface command to tell the DMM to take a current measurement, and return it. When this has been received, the computer opens all the switches in the switch matrix, and a few seconds later a printer churns out a result sheet, like the one shown in Fig. 3 (Produced by an Apple).

SYNCHRO MOTORS				
ACCEPTANCE TEST CERTIFICATE				
TEST DATE	:	81/08/04		
OPERATOR	:	JOHN		
SERIAL NO.	:	M100-70		
MOTOR TYPE	:	12V DC/M100		
TEST		RESULT	LIMITS	UNITS
TEST 1. COIL RESISTANCE		97.8	96 TO 104	OHMS
TEST 2. MOTOR RUN UP TIME	F	0.56	< 0.5	SECS
TEST 3. MOTOR RUN CURRENT		10.3	< 11.5	MA
PASSED BY :				
SIGNATURE :				
DATE	:			
014 231/81 ISSUE 1				

Fig. 3. Results sheet

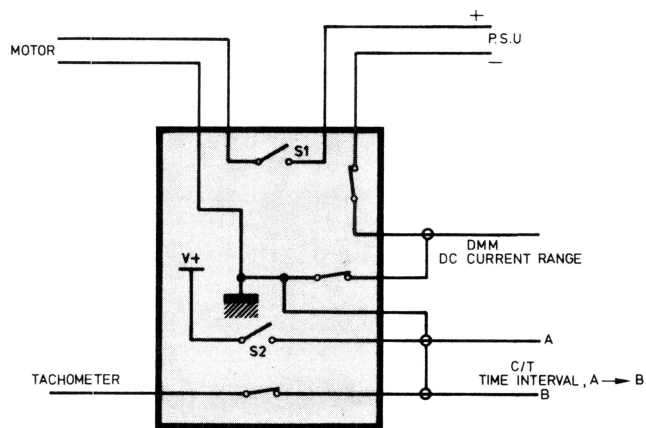


Fig. 2b. Switching matrix ready to start timing

What was achieved? The test was completely error proof. No misread readings, inaccurate timings, or when applicable, calculation errors. And most important, the actual time-to-test was very significantly reduced. Remember too that the computer sets up the instrument ranges automatically and that self check routines can be incorporated to provide reliable test equipment.

Consider the variety of devices available (a sample will be given below) and one can begin to realise the power automatic testing has, and the cost saving it can produce. The author has recently completed an ATE system that simultaneously tests four highly sophisticated electromechanical devices, using no less than twelve different instruments, all controlled by an Apple! A two hour manual test was reduced to a twenty minute for one, forty five minutes for four, completely automatic, reliable, consistent, test.

SOME DEFINITIONS

The host computer in the example above is for obvious reasons called the CONTROLLER. The switch matrix only receives instructions and is called a LISTENER. The DMM and C/T on the other hand listened to the controller (when their ranges were being set up) and talked back by sending the measurements taken. They are referred to as LISTENER/TALKERS. Most instruments can be switched to be a talker only, so that the instrument is controlled from the front panel, but readings are sent to a controller or another listener (such as a printer).

Fig. 1 indicates that all the instruments are connected to the same bus, so some means of differentiating between instruments



HP5335A universal timer/counter

is required. This is achieved by allocating each instrument a specific ADDRESS between decimal 0 and 30 by selecting that address on a set of switches provided at the rear of each instrument. The controller thus addresses each instrument before sending data to, or receiving data from that particular instrument or device.

BUS DEVICES

The types of bus devices can be broadly divided into different groups. A discussion and explanation of the main groups follows, and examples of each type of device can be found in Table 1, with an indication of which vendors supply what equipment. Note that the list of devices and names of vendors is **by no means complete** and is only meant to be an illustration. Note also that HP, who developed the bus and thus have had most experience with it, have the largest variety of devices available. A glance through the HP instrumentation catalogue is most informative and enlightening.

Controllers

These have already been defined above, and almost always are one form or another of mini- or microcomputer. The HP9825 has for a long while been the industry standard, but today the HP9826 replaces it. Fluke market a sophisticated controller, the model 1720A. And in the less expensive range, although not necessarily less powerful, the Apple or the Pet. Nearly all other mini- or microcomputer manufacturers offer GPIB capability either as a standard, or as an add-on option.

Measurement Devices

A device exists, made by one or other manufacturer, for just about any conceivable measurement requirement. The complexity (and price!) of each variety of instrument in the group ranges from, for example, the simple voltmeter which just sends readings to the controller, to the sophisticated DMM, which can do statistical analysis of the readings taken, or test for readings between pre-programmable limits, or store the highest, or lowest reading taken in any interval of time. The same level of sophistication is also available for many of the other types of devices in this group shown in Table 1.

Stimuli Devices

As the name implies, this group of devices include those which provide analogue or digital stimuli to the UUT, or provide power to the UUT. Again sophistication is built into some of these instruments, so that previous setting up parameters can be stored and instantly recalled, without having to re-program the instrument.

Output Devices

The group includes printers, X-Y plotters, VDUs and the like.

Storage Devices

Floppy—and hard disk drives are available.

Switching Matrices

In essence, these devices allow the automatic routing of stimuli to and measurement signals from, the UUT via plug-in modules which consist of sets of relays connected either as in

Table 1. Bus devices and manufacturers—a sample of what is available

	H-P	FLUKE	WAVETEK	RACAL DANA	SYSTRON DONNER	GOULD ADVANCE	KEPCO	ROCKLAND DIGIPLAN	PHILIPS	TEKTRONIX
MEASUREMENT DEVICES										
Digital Multimeters	3438A 3455A MANY MANY MANY TWO MANY	8860 8520 1953A		μ5000 9514	7344A 6042A	K100-D			PM2526 PM2528 MANY MANY PM3310	
STIMULI DEVICES								512-S		492P MANY
RF Generators	8660A	6070A	MANY							
Synthesizers	3325A		178		1702				PM5190	
Pulse Generators	5359A		MANY		154-4					
Digital Pulse Gens.	8170A				DPSD-50		MANY		PE1367	
DC Power Supplies	59501A 6002A									
OUTPUT DEVICES										
Printers	MANY								PM8151	4662
X-Y Plotters	7225A									
STORAGE DEVICES										
Floppies	9895									
Digitizers	9874A									
SWITCHING MATRICES										
Switching										
DACUs	3497A			1200	3570A				PM4012	
OTHER DEVICES										
Filters										
Stepper-motor drives								MANY		
HP1B Extenders	37201A 59403A							1185-105		

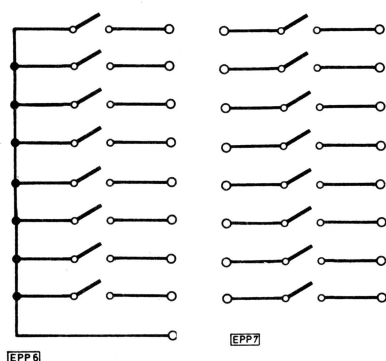


Fig. 4 (far left). Eight relays connected as a multiplex module. Note only one relay may be closed at one time

Fig. 5. Eight relays connected as a relay module. Any number may be closed at any time

Fig. 4 or Fig. 5. They allow measurement and stimuli highways to be formed, an example given in Fig. 6. The number of switches or relays is expandable by simply adding more modules, and different types of modules are available viz. reed relay switching, power relay switching, FET switching and coaxial relay switching amongst others.

Many manufacturers of ATE systems offer modular switching systems and supporting modules such as D/A converters, A/D converters, peak detectors and the like. HP market various multiprogrammers for measurement and control applications (here called DACUs—for Data Acquisition and Control Units). These have a large variety of plug-in modules to suit. For those with a small business ATE application such as the example above in mind, this type of unit provides the easiest and relatively cheapest way to begin.

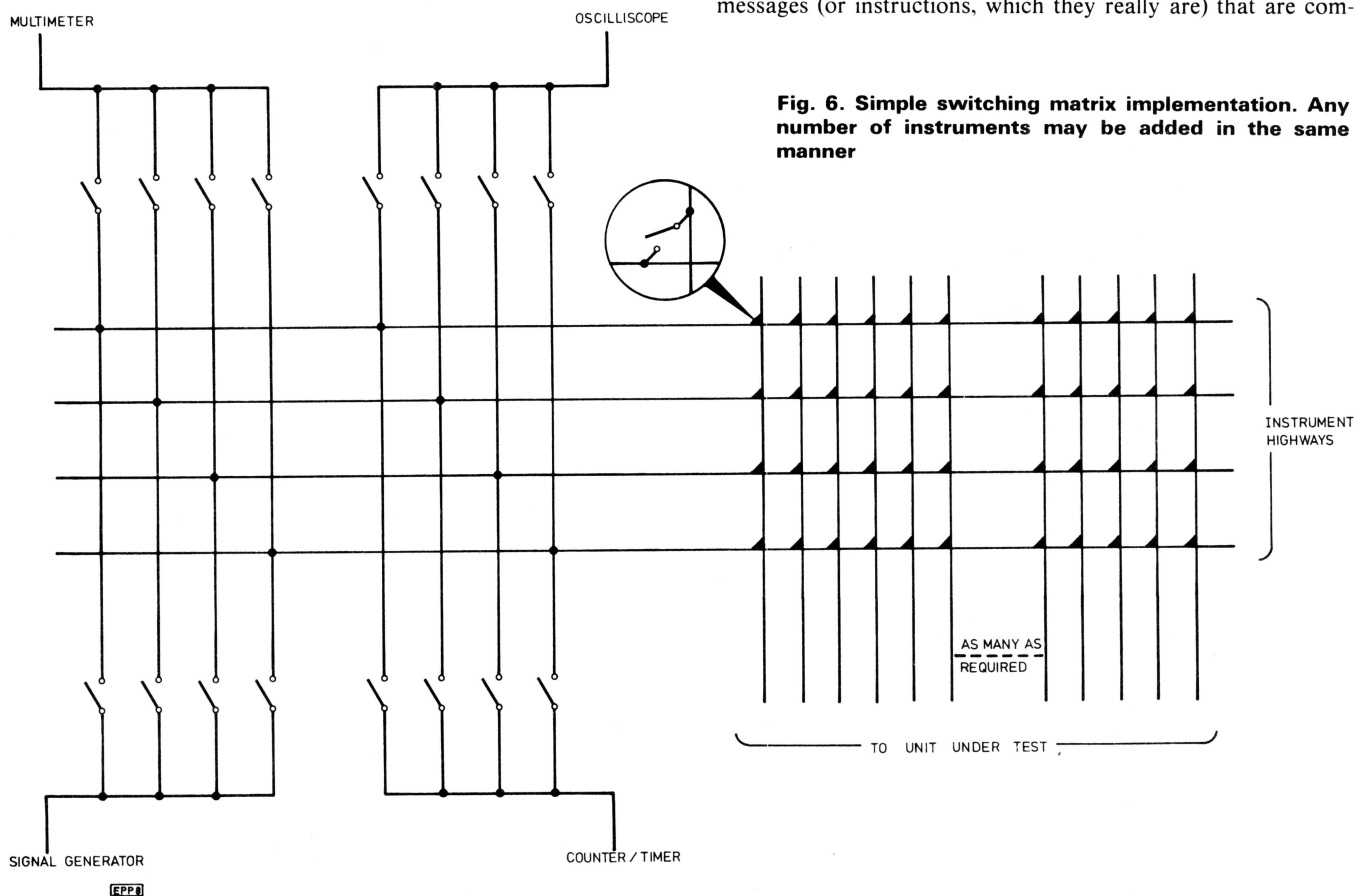


Fig. 6. Simple switching matrix implementation. Any number of instruments may be added in the same manner

Table 2. IEEE-488 standard subsets

Subset Mnemonic	Function
SH1	Source Handshake
AH1	Acceptor Handshake
T5	Talker
TE0	Extended Talker
L4	Listener
LE0	Extended Listener
SR1	Service Request
RL1	Remote/Local
PP0	Parallel Poll
DC1	Device Clear
DT1	Device Trigger
C0	Controller

Other Devices

Analogue and digital programmable filters are available, as well as stepper-motor drives. The list is endless, it keeps growing daily.

MORE DEFINITIONS

It is necessary to say here that the standard divides the major functions of the bus into twelve SUBSETS. An instrument that is a TALKER and a LISTENER implements at least two of these subsets. The controller function is another, for example. Table 2 gives all the possible major subsets, although only a few will be discussed here. Now since an instrument need only implement at least two subsets to be able to communicate in one way or another on the bus, it need only understand the interface messages (or instructions, which they really are) that are com-

mon to those subsets it implements. These interface messages then are instructions that are defined in the standard and must be understood by all instruments, meant to implement the subsets using these instructions. A few of these instructions are discussed in the example below.

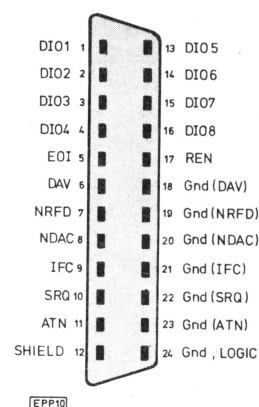
Device-dependant messages, on the other hand, are messages that are transmitted by the bus. They usually take the form of either data (measurements) which are normally in a form that all instruments can decode or instructions for the control of the instrument itself (hence "device-dependant") that is normally peculiar only to the instrument being addressed.

It was previously mentioned that the instruments may be set up for any address between 0 and 30 decimal. Referring to Table 3 one can see that corresponding to each decimal address are two ASCII characters depending on whether bit D6 or bit D7 is a "1". These two characters determine whether the instrument is to talk, or listen, when addressed. For example, an instrument set to address 01 would know it was being addressed to talk when it detected an "A" on the bus (MTA—My Talk Address in 488 jargon) and would respond as a listener when it detected a "l" (MLA—My Listen Address).

Now for an example: Assume the controller has address 21 (normal for the HP 9825) and that it is going to set up a Fiuke DMM to measure d.c. volts and return the measurement. Refer to Figs. 7 and 8. Fig. 8 shows the pinout of the 488 controller which will be discussed later, but will be found useful to refer to in the example. The instrument is set to address 04. The following sequence of events occurs.

- 1 REN line (remote ENable) goes low. All instruments on the bus go into the remote state.
- 2 IFC (InterFace Clear) pulses low. Stops activity on the bus.
- 3 ATN line (ATtentionN) goes low. Informs all instruments that the following data is an interface message.
- 4 NRFD (Not Ready For Data) line is high. This line is one of

Fig. 8. Bus connector pin-out



the three handshake lines and because it is high (remember, the bus works with inverse logic being true) all instruments are ready to accept data. Note that since all the handshake lines have open collector outputs, the line will stay low until the slowest instrument is ready. Thus for all the handshaking, the slowest instrument on the bus determines the speed of the bus.

- 5 The ASCII character ? for UNL (UNListen) is put on the data lines. This bus instruction deselects any instruments that may previously have been set up as listeners. The character stays on the bus for the whole of the following handshake cycle.
- 6 DAV line (Data Valid) goes low. Controller says data is valid.
- 7 NRFD line goes low. Instruments say do not change data while we are reading it.
- 8 NDAC line (Not Data ACcepted) goes high when all instruments have accepted the data.

Fig. 7. Bus handshake timing diagram

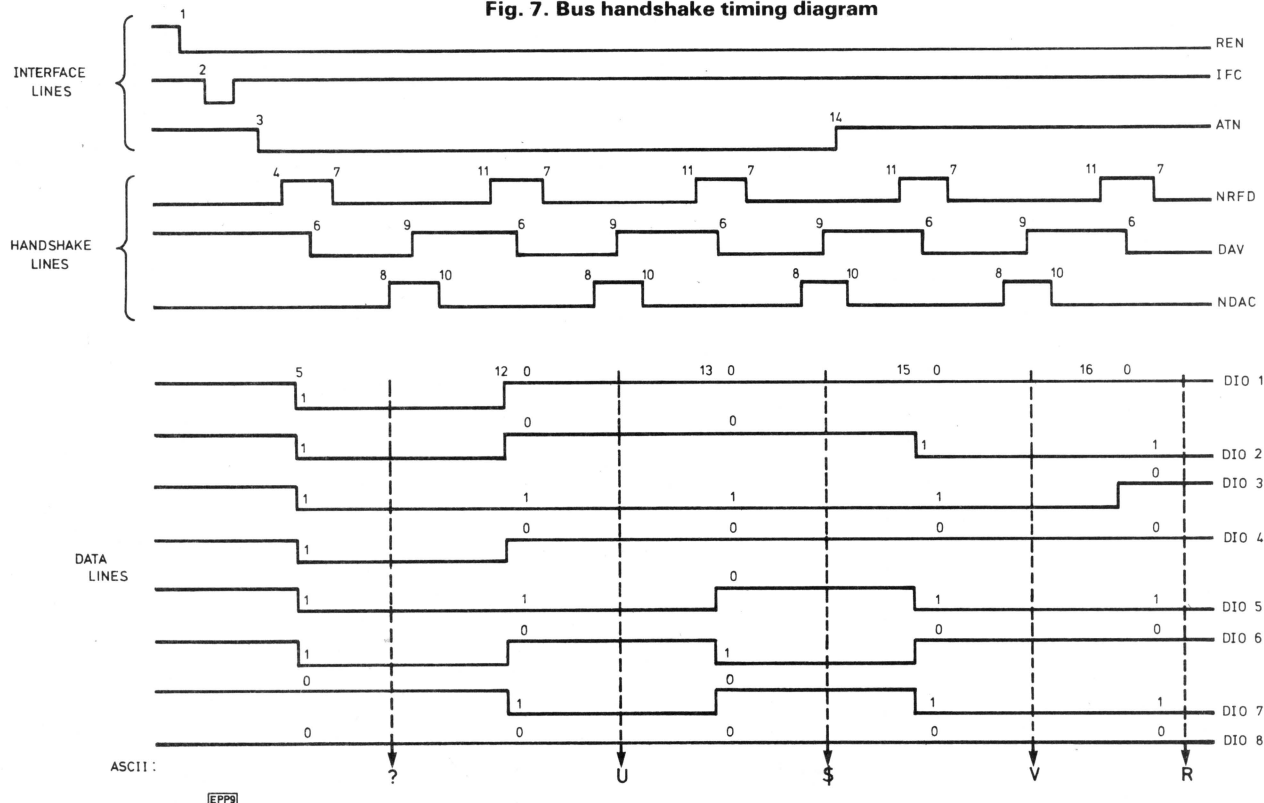


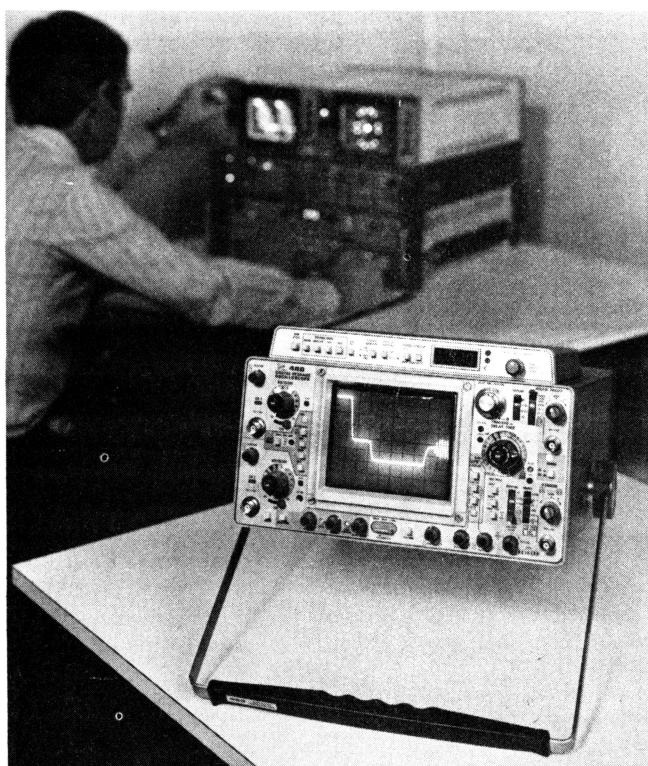
Table 3. Decimal and equivalent ASCII TALK and LISTEN addresses.

ASCII characters		DATA LINES							DECIMAL ADDRESS
		D ₇	D ₆	D ₅	D ₄	D ₃	D ₂	D ₁	
T A L K	L I S T E N	T A L K	L I S T E N	ADDRESS					
				16	8	4	2	1	
@	SP	0 1	0 1	0 0	0 0	0 0	0 0	0 0	00
A	!	0 1	0 0	0 0	0 0	0 0	0 0	1 1	01
B	"	0 1	0 0	0 0	0 0	0 0	1 1	0 0	02
C	#	0 1	0 0	0 0	0 0	0 0	1 1	1 1	03
D	\$	0 1	0 0	0 0	0 0	1 1	0 0	0 0	04
E	%	0 1	0 0	0 0	0 0	1 1	0 0	1 1	05
F	&	0 1	0 0	0 0	0 0	1 1	1 1	0 0	06
G	(APOSTROPHE)	0 1	0 0	0 0	0 0	1 1	1 1	1 1	07
H	(	0 1	0 0	0 0	1 1	0 0	0 0	0 0	08
I	)	0 1	0 0	0 0	1 1	0 0	0 0	1 1	09
J	*	0 1	0 0	0 0	1 1	0 0	1 1	0 0	10
K	+	0 1	0 0	0 0	1 1	0 0	1 1	1 1	11
L	,	0 1	0 0	0 0	1 1	1 1	0 0	0 0	12
M	—	0 1	0 0	0 0	1 1	1 1	0 0	1 0	13
N	.	0 1	0 0	0 0	1 1	1 1	1 1	0 0	14
O	/	0 1	0 0	0 0	1 1	1 1	1 1	1 1	15
P	Ø	0 1	0 0	1 1	0 0	0 0	0 0	0 0	16
Q	1	0 1	0 0	1 1	0 0	0 0	0 0	1 1	17
R	2	0 1	0 0	1 1	0 0	0 0	1 1	0 0	18
S	3	0 1	0 0	1 1	0 0	0 0	1 1	1 1	19
T	4	0 1	0 0	1 1	0 0	1 1	0 0	0 0	20
U	5	0 1	0 0	1 1	0 0	1 1	0 0	1 1	21
V	6	0 1	0 0	1 1	0 0	1 1	1 1	0 0	22
W	7	0 1	0 0	1 1	0 0	1 1	1 1	1 1	23
X	8	0 1	0 0	1 1	1 1	0 0	0 0	0 0	24
Y	9	0 1	0 0	1 1	1 1	0 0	0 0	1 1	25
Z	:	0 1	0 0	1 1	1 1	0 0	1 1	0 0	26
[	;	0 1	0 0	1 1	1 1	0 0	1 1	1 1	27
\	<	0 1	0 0	1 1	1 1	1 1	0 0	0 0	28
]	=	0 1	0 0	1 1	1 1	1 1	0 0	1 1	29
^	>	0 1	0 0	1 1	1 1	1 1	1 1	0 0	30

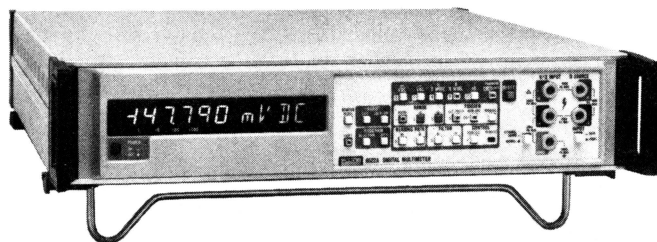
- 9 DAV goes high. Data no longer valid.
- 10 NDAC low. Instruments remove data accepted indication.
- 11 NRFD goes high. Instruments ready for next data byte.
- 12 Controller puts character U on the bus indicating that it is going to be the talker. Steps 6 to 11 are repeated, i.e. the handshake is completed.
- 13 The controller puts \$ on the bus. This is the Fluke's LISTEN address. Steps 6 to 11 are repeated, however, only the DMM is doing the handshaking, as only it recognises its listen address. Until stated to the contrary, steps 6 to 11 occur after each byte of data is transmitted, and are controlled by the DMM and the controller only.
- 14 ATN goes high. Interface message finished, device dependant message follows.
- 15 V on the bus. The DMM understands this to mean Volts d.c. This and the following few characters are totally device-dependant messages and are understood by the particular instrument only.
- 16 R range
- 17 ? Auto range
- 18 M Programs off
- 19 0
- 20 T Internal trigger
- 21 0
- 22 ? Terminator that forces the DMM to act on this string of data and take a reading, i.e. on V d.c. and auto range.
- 23 CR Carriage return. Indicates to the instrument end of data message.
- 24 LF Line Feed
- 25 ATN low—following message is an interface one.
- 26 ? on data bus—Unlisten again (all instruments respond).
- 27 D on data bus—Controller tells Fluke it must talk. Only the Fluke recognises this, so again, only it will respond.
- 28 5 on the bus—Controllers' own listener address.
- 29 ATN high. end of interface message. The DMM can now send its measurement.
- 30 +
- 31 0
- 32 0
- 33 0
- 34 0
- 35 .
- 36 0
- 37 3
- 38 E
- 39 +
- 40 0
- 41 2

It may seem a bit long-winded to go through all that to transfer data, but it takes just a fraction of a second to occur, and the handshake ensures correct data transmission. Another explanation of the handshake cycle is shown in the form of a flow chart in Fig. 9. In the above example, when the controller is talking, it is referred to as the SOURCE and it controls the DAV line, while the DMM, which is listening, is called an ACCEPTOR, and controls the NRFD and NDAC lines. The names and lines each device controls are of course reversed when their respective listen and talk roles are reversed.

The only other line so far not discussed is the SRQ (Service ReQuest) line. This line is used by instruments to indicate to the controller that they require service. The instruments can be programmed to ask for service when some special conditions occurs, such as a hardware or software or programming error,



Tektronix 468 digital storage oscilloscope



Fluke 8522A computing/systems DMM



Hewlett Packard 8903A transceiver test set under the control of an HP85F

when a reading has been completed, or when some other, or combination of other, instrument-defined conditions occur. The controller then does either a Serial or Parallel Poll to discover which instrument sent the SRQ and acts on the SRQ as programmed. The actual Serial or Parallel Poll implementation is outside the scope of this article.

MORE INTERFACE DEFINED INSTRUCTIONS

A few more interface defined instructions, which are used most often, follow. They can be broadly grouped as shown and are all sent with the ATN line low.

Unaddress Commands

These do what the name implies.

UNL—UNListen Clears the bus of all listeners (ASCII ?)

UNT—UNTalk Clears the bus of all talkers (ASCII ^)

Universal Commands

All instruments respond to these commands, whether they had previously been addressed or not.

LLO—Local LLockout Disables front panel controls (ASCII DC1)

DCL—Device CLear Returns all devices to a cleared state (ASCII DC4)

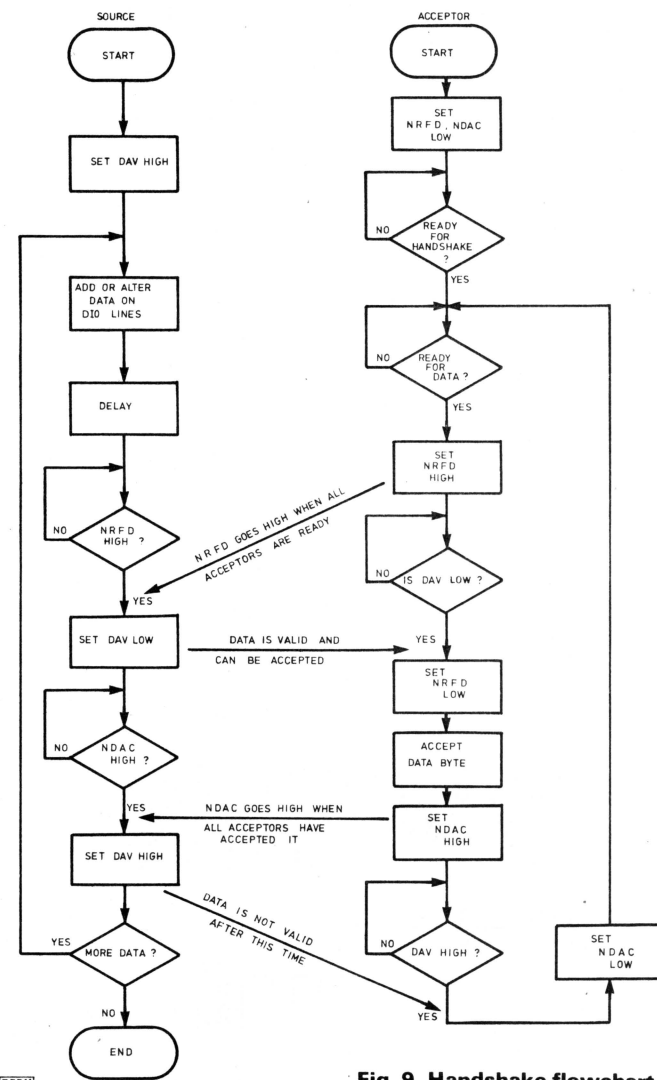


Fig. 9. Handshake flowchart



Fluke 8860A DMM

Other commands in this category are commands that allow Serial or Parallel Polling as mentioned above. Refer to Ref. 1 for more details.

Addressed Commands

Commands which affect addressed instruments only.

GTL—Go To Local Enable the devices front panel controls (ASCII SOH).
SDC—Selective Device Clear Clears only the selected (addressed) device on the bus (ASCII EOT).

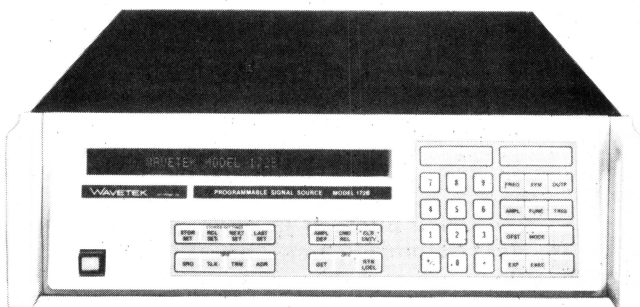
GET—Group Execute Trigger Start-all preset-up instruments simultaneously (i.e. to start taking a measurement — ensures simultaneous measurements with different devices).

TCT—Take Control Pass control from the present controller to another. This facility is seldom found on controllers, mainly due to the complexity of providing the facility and because the facility is seldom required.

There are many others, but these examples suffice to show the bus capabilities.

HARDWARE

The physical connector, as already mentioned, is shown in Fig. 8. The bus standard allows for a maximum of 15 instruments at one time (including the controller) and a total cable length of 20 metres. Buffer units are available to expand this, but are rarely required. Standard cables are available to do the inter-



Wavetek 172B programmable signal source

Table 4: IC's—types and manufacturers

Manufacturer	Part Number	Function	Supply (V)	Clock (MHz)	Transfer Rate (bytes/sec)
Fairchild	96LS488	Talker/Listener	5	10	1M
Intel	8291	Talker/Listener/Controller	5	8	448k
Motorola	8292	Talker/Listener	5	6	125k
Philips/Signetics	HEF4738V	Talker/Listener	4.5-12.5	2	200k
Texas Instruments	TMS9914	Talker/Listener/Controller	5	5	250k

connecting and must usually be ordered separately from the device manufacturers.

BUS INTEGRATED CIRCUITS

The major chip manufacturers, Motorola, Intel, Fairchild, Philips and Texas Instruments all produce VLSI integrated circuits which can be used as building blocks for building a bus interface. The chips are designed to work with their respective microprocessor families, however they can be used with other micros as well. For amateur use, the Motorola MC68488 chip is probably the best to use, as it interfaces well with the 6502 microprocessor, which is the micro used in most home computers. Table 4 shows some of the versions available.

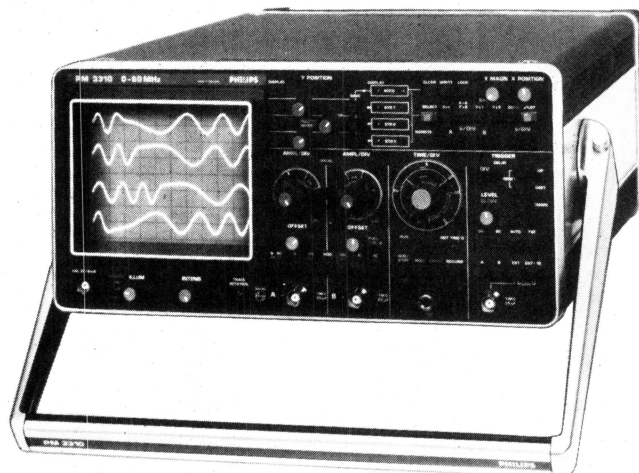
Although the task of designing one's own interface seems nearly impossible to the hobbyist at first glance, this is not really so. The integrated circuits are not expensive, application data is freely available and the chips themselves remove most of the complicated work. It is in this area that the hobbyist can really get going without too much expense.

CONCLUSION

It is hoped that some light has been thrown on ATEs in general and the IEEE-488 bus in particular. Perhaps (hopefully!) some minds have been set thinking and home computers (and others) may now be used in a new direction, as well as for the usual financial uses and of course, games!

(Ref. 1—IEEE STANDARD DIGITAL INTERFACE FOR PROGRAMMABLE INSTRUMENTATION—published by the IEEE inc. New York.)

If you do use your computer in this way or are interested in so doing, perhaps you could let us know (Ed.)



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Signature Analyser

IMPROVEMENTS in technology have brought about a lot of changes in digital circuitry design. Random logic designs have been replaced by software based designs such as microprocessors and algorithmic state machines. Hardware has been replaced by processor's firmware. Elements like ROMs and PROMs contain programs that represent software algorithms for control circuits. Methods for testing digital modules that are software oriented are quite different from those used to test random logic. Instruments like an oscilloscope and DVM are no longer sufficient. The problem can be solved partly by using a logic state analyser. The algorithm can be traced and when the erroneous state occurs, the faulty element can be sought.

A simple logic probe is a very economic and useful device but unfortunately it can display only a few states of digital circuitry. It cannot distinguish different data streams in different nodes of digital circuits. This article describes a digital logic probe that can display not only 'low', 'high' and 'pulse train', but also a stream of digital data at different nodes of circuit inside a predefined time window. The probe is in fact a miniature hand held Signature Analyser.

The circuit has been kept as simple as possible, so that it can be implemented with standard elements and yet can be placed in an enclosure no bigger than that of an ordinary logic probe. Testing digital boards with this handy tool is quite easy only if the boards are designed so that the circuit under test generates signals which can be used for generating a time window in which the periodic stream of digital data at different nodes can be observed.

DEFINING IT

A Signature Analyser is an instrument for testing and de-bugging digital circuitry. The most essential part of the device is a CRC encoder that serves as data compressor. CRC stands for 'cyclic redundancy check' which is an error checking technique commonly used in serial data transmission or data recording systems (discs, tapes, etc.). Digital data stream compression is obtained by polynomial division of data by the generator polynomial. The remainder of this is the CRC value or signature of a particular data stream.

Division is implemented in a serial shift register, where feedback loops determine the generator polynomial. The remainder is always in relation to all data bits in the digital stream that entered the feedback register. Fig. 1 illustrates the principle of operation.

By comparing the signature in a node of a circuit to an empirically determined correct signature, we can verify circuit operation. The element where all signatures on the inputs are correct and signatures on the output pins are incorrect is the faulty one and should be replaced.

DESIGN OF THE PROBE

The probe is intended to test digital circuits with TTL signal levels. It is designed to be as small as possible so as to be no bigger than an ordinary logic probe. It is also built with standard SSI and MSI integrated circuits. Since a relatively large number of elements is placed in a small enclosure, problems related to power dissipation might occur. The use of CMOS elements has solved this but CMOS elements are relatively slow devices when used with 5V power supply and thus the maximum frequency of input signals is 50kHz. Signatures can be observed on a 4-digit seven segment multiplexed display. The selected characters are presented in Table 1.



A.TREBAR

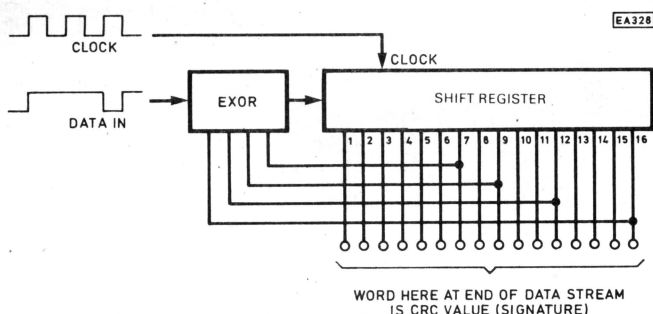


Fig. 1. The CRC encoder

SIGNAL INPUTS

The following signals are inputted to the probe:

Clock Is the clock of the **unit under test (UUT)**. Because of speed limitation the clock of the UUT should be slowed down to 50kHz.

Start Time window in which the measuring takes place is started by a start pulse. This signal is also generated by UUT. The probe is designed so that the beginning of the time window can be selected on the falling or rising edge of the start pulse.

Stop Stop pulse terminates the time window. The termination of the time window can be selected on the rising or falling edge of the stop pulse.

All signals mentioned above are entering the probe through the microphone jack on the rear side of the probe.

Data Is a digital data stream of the unit under test that enters the probe through the probe tip.

Power Probe is connected to a power supply of UUT by alligator clips.

Table 1: HEX-to-alphanumeric decoder

2 ³	2 ²	2 ¹	2 ⁰		a	b	c	d	e	f	g
0	0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	1	0	1	1	0	0	0	0
0	0	1	0	2	1	1	0	1	1	0	1
0	0	1	1	3	1	1	1	1	0	0	1
0	1	0	0	4	0	0	1	0	0	1	1
0	1	0	1	5	1	0	1	1	0	1	1
0	1	1	0	6	1	0	1	1	1	1	1
0	1	1	1	7	1	1	1	0	0	0	0
1	0	0	0	8	1	1	1	1	1	1	1
1	0	0	1	9	1	1	1	1	0	1	1
1	0	1	0	A	1	1	1	0	1	1	1
1	0	1	1	C	1	0	0	1	1	1	0
1	1	0	0	F	1	0	0	0	1	1	1
1	1	0	1	H	0	1	1	0	1	1	1
1	1	1	0	P	1	1	0	0	1	1	1
1	1	1	1	U	0	1	1	1	1	1	0

CIRCUIT

Fig. 2 is the circuit diagram of the logic probe. The whole can be divided into three basic parts: a circuit for generating the time window, data compressing circuit and a circuit for latching signatures and multiplexing the display.

The circuit for data compression is implemented by IC1, IC2 and IC5. IC1 and IC2 are connected to form a 16-bit shift register with serial input and parallel outputs. Bits 7, 9, 12 and 16 are EXORed together with the data input stream in IC5. The result of this summation is made to enter a serial input shift register.

The data stream enters the linear feedback shift register during a preselected 'time window', which is determined by start and stop signals.

This is generated with circuits IC8 and IC9. IC9 is a quad NAND gate, and a half of it is connected to form an RS flip-flop. A start pulse triggers the flip-flop by a negative going pulse at IC9/13. This initiates the time window. When a negative pulse is applied to IC9/8 the window period terminates. The other half of IC9 and four Schmitt triggers from IC8 are used to generate short negative going pulses for triggering the RS flip-flop. By setting the switch S1 we can select whether the triggering pulse will appear at the leading or trailing edge of the input pulse. Fig. 3 illustrates how trigger pulses are generated. Note that the trigger pulse width is determined by propagation delay of the Schmitt trigger. During the window time the serial data stream is entering the linear feedback shift register. After the appearance of the stop pulse information contained at the parallel output pins of the feedback register represents the signature of the stream.

The signature is loaded to IC3 and IC4 which are parallel input—serial output shift registers and are used for storing the signature and for multiplexing the display. The signature is jammed into the register via the parallel input lines asynchronously of the clock at the positive pulse (1μs) on IC8/8 and displayed on a 4-digit seven segment l.e.d. display (HP-5082-7405).

DISPLAY

The circuit for displaying the signature is implemented by IC3, IC4, IC6, IC7, IC8 and IC10. Shift registers IC3 and IC4 (CD 4021B) are parallel input—serial output devices, with three parallel outputs: Q6, Q7 and Q8. Two are used for multiplexing the display.

The serial outputs of IC3 and IC4 are connected to the serial inputs of the same units so that information in the shift registers is cycling with the frequency of a clock provided by UUT. Parallel outputs Q7 and Q8 from IC3 and IC4 are connected to the address pins of IC7 (6331) which is 32 × 8 PROM, used for binary to seven segment code conversion as is shown in Table 1. All segments of the l.e.d. display are directly driven from IC7 with the exception of segment f which is driven by IC10 a-b. The display is multiplexed by applying negative pulses to the common cathode outputs of IC11 at the time when correct data is waiting at the address input of IC7.

IC6 is BCD by 8 counter divider. When the signature is loaded to IC3 and IC4 the L/S pulse at IC8/8 clears IC6 and so synchronises it with the contents of IC3 and IC4. Since the information contained in IC3 and IC4 is cycling, the valid output at Q7 and Q8 will only be at each second clock pulse. That is why only each second output of IC6 is used for driving the common cathodes of the l.e.d. display. However CMOS circuits like the 4022A cannot sink enough current to drive a l.e.d. display directly, so IC10 is used as a cathode driver.

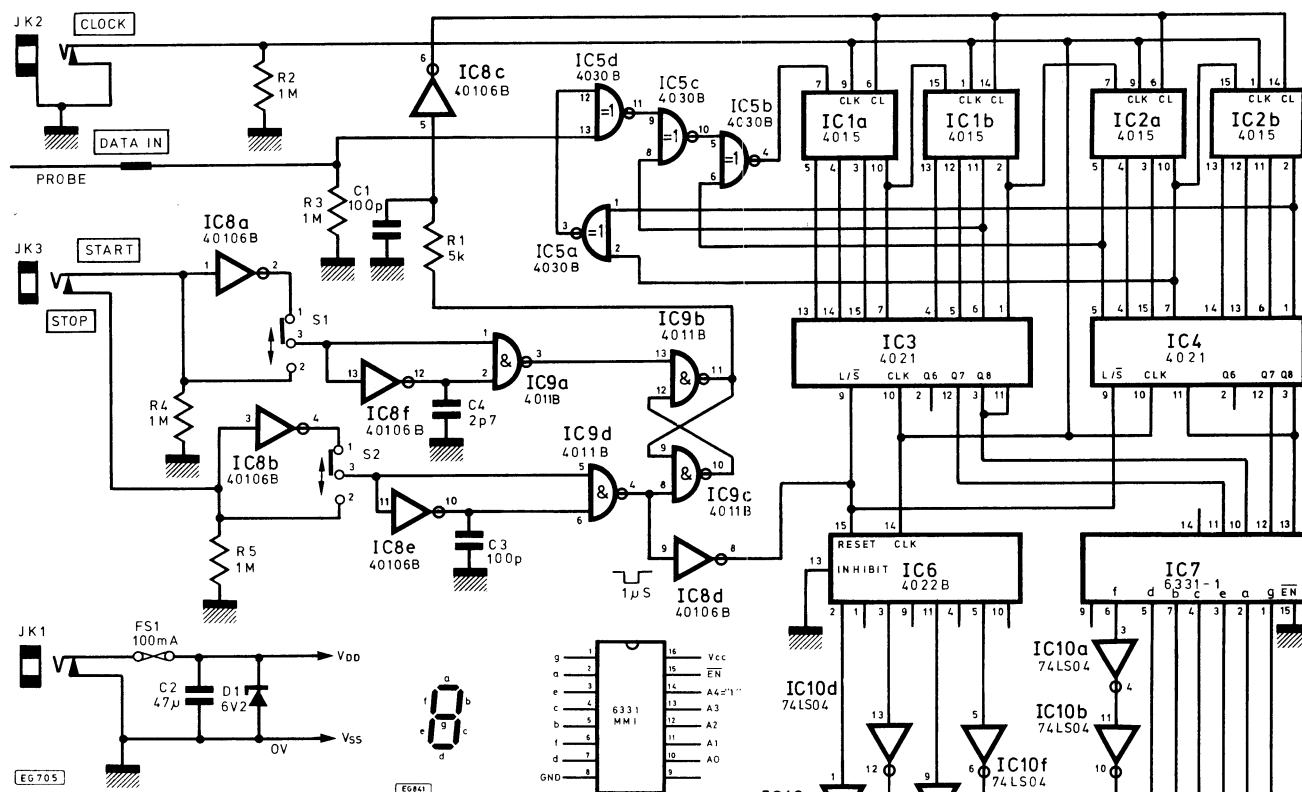
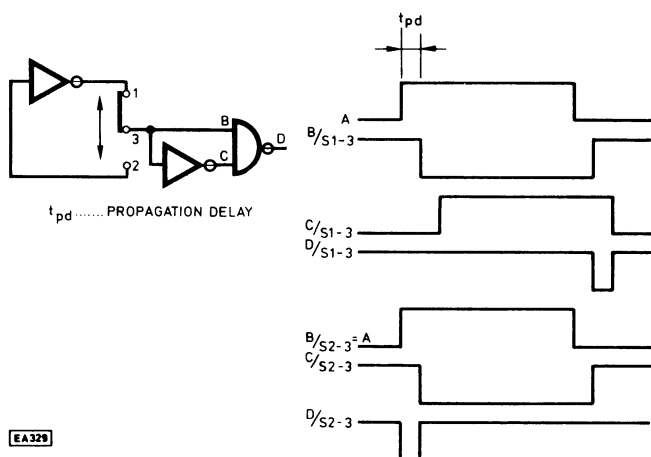


Fig. 2. Circuit of Signature Analyser

Fig. 3. Edge selector



CONSTRUCTION

The circuit is implemented on two single sided printed circuit boards which are mounted vertically in the enclosure. The boards are positioned so that the interconnection between chips is as simple as possible. Fig. 4 shows the component placement and foil pattern. Fig. 5 illustrates how the display is soldered to the p.c. board. Pins from 1 to 7 are stretched and are then soldered. The other pins are soldered to the jumpers so that when the board is mounted in the enclosure the display can be easily observed through the display bezel/filter on top of the probe. Control signals (Start,

Stop and Clock) enter the probe through phono jacks on the rear end of the probe. The cable to the probe should be short enough to avoid ringing problems. For a given frequency this won't occur if the cable is no longer than 1m.

The data stream enters the probe through the tip. Two switches on top of the probe are provided for selecting the time window. These are miniature SPDT type.

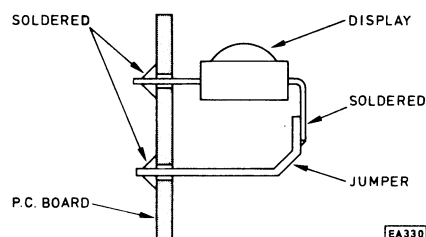
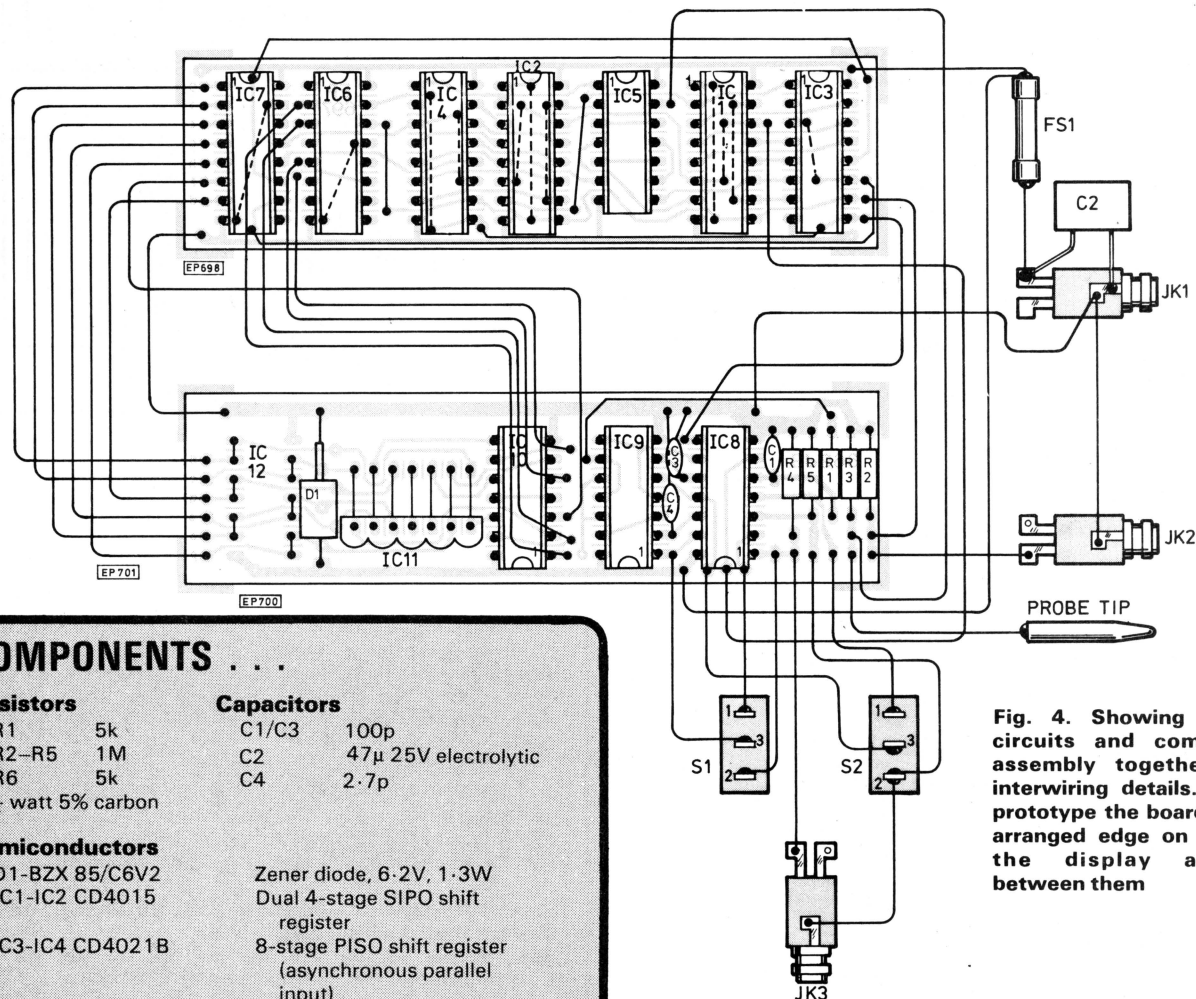
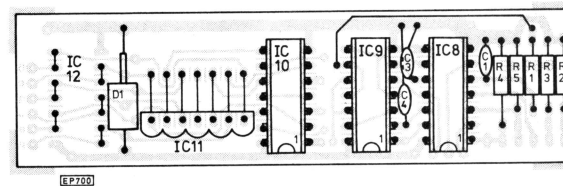
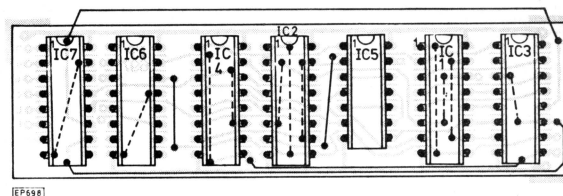
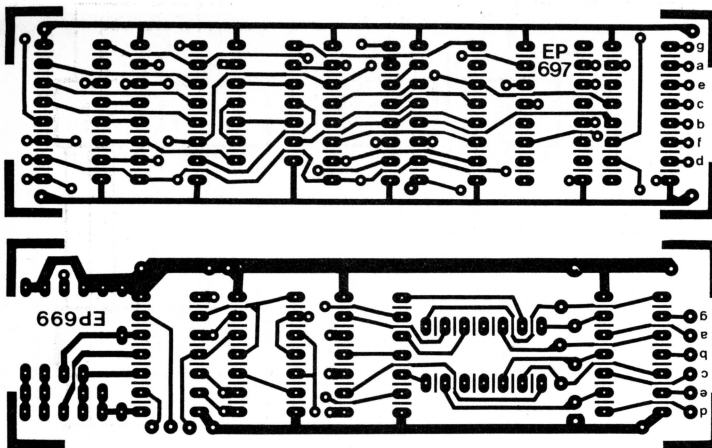


Fig. 5. Showing how display is soldered to p.c. boards

USING THE PROBE

How useful the probe could be is evident from a relatively simple problem. Let's assume that we need to test the content correctness of a 2K x ROM circuit. We can see that the task is not an easy one if we have to read the contents of every address location and then compare it to the value in



COMPONENTS . . .

Resistors

R1	5k
R2-R5	1M
R6	5k
$\frac{1}{4}$ watt 5% carbon	

Capacitors

C1/C3	100p
C2	47 μ 25V electrolytic
C4	2.7p

Semiconductors

D1-BZX 85/C6V2
IC1-IC2 CD4015

IC3-IC4 CD4021B

IC5-CD4030B

IC6-CD 4022B

IC7-6331-1

IC8-CD40106B

IC9-CD4011B

IC10-74LS04

IC11-5082-7405

IC12-7404

Zener diode, 6.2V, 1.3W

Dual 4-stage SIPO shift register

8-stage PISO shift register (asynchronous parallel input)

Quad exclusive OR

Divide by 8 counter/divider

PROM 32 \times 8, three state (MMI)

Hex Schmitt trigger

Quad 2-input NAND

Hex inverter

5-digit, common cathode numeric indicator (Hewlett-Packard)

Hex inverter (optional)

IC7 and IC11 can be obtained from **Ace Mailtronix Ltd., 3A Commercial St., Batley, West Yorks, WF17 5HJ**

Miscellaneous

FS1	100mA/fast
JK1-JK3	miniature 2.5mm chassis connector (RS 478-526)
S1-S2	miniature SPDT switch case, tip, pins, cable, clips, PC-boards.

Fig. 4. Showing printed circuits and component assembly together with interwiring details. In the prototype the boards were arranged edge on so that the display appears between them

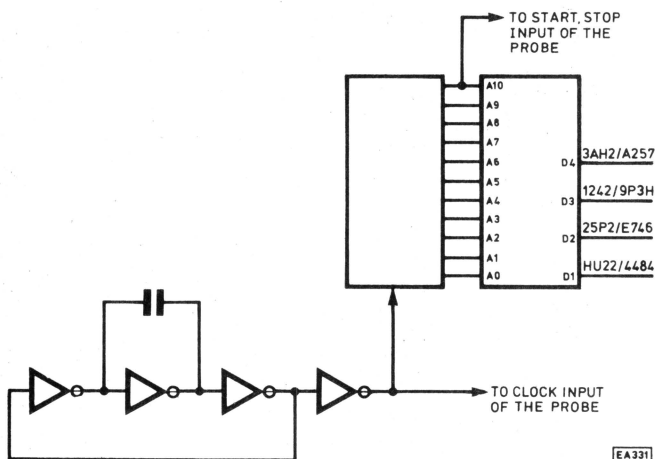


Fig. 6. Contents of the display when the probe tip is successively applied to the output pins

The best results can be obtained if circuit of unit under test is designed with the concept of signature analysis in mind. This means that it must be designed so that feedback bus loops can be opened. The problem is that unless the feedback loops are not broken, the failure in one member of the loop will propagate bad signatures all the way around the loop. ★

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DATA Dynamics 390 printer. Suits UK101 £99, also Creed 7B printer £20. Tel: Wivenhoe 020622 5671 evenings.

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MINI-SYNTH stylophone eight voices plus vibrato waa-waa pedal facility, £30. Tel: Mr. Hiron, Barnet 01-441 5123.

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PET 3016 computer 16K. Excellent condition with toolkit cassette deck some software £500. Tel: Macclesfield 21703 evenings.

TELETYPE with stand for sale £50 o.n.o. Has paper tape reader, punch also. Good working order. Tel: 0933 624767 evenings.

PANEL with over 60 T.M.C. switches and 45 miniature indicators. Bargain £10 plus cost of postage. David E. Smith, 62 Newsgate Road, Sale, Cheshire.

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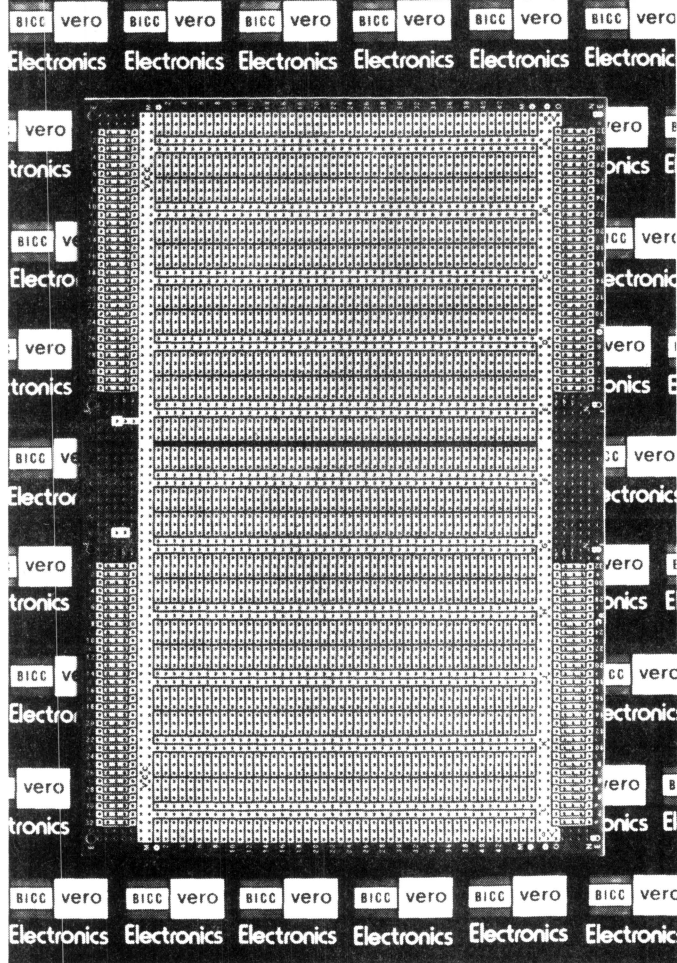
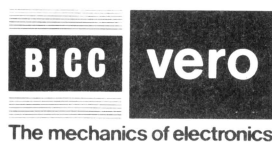
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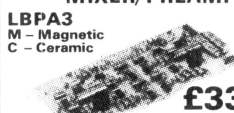
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A major problem encountered when connecting transducers to their attendant amplifiers is the dreaded "common-mode-noise." Common-mode simply means that the noise voltage is induced in both connecting wires equally in sign and magnitude, and this is the normal situation where the connecting wires act rather like receiving aerials. If the amplifier has a so called "single-ended" input (i.e. single and earth) the induced noise voltage is amplified along with the signal, which is bad news of course. To overcome this problem you can use an OP-AMP along with four resistors in a differential input configuration so that advantage can be taken of the Common Mode Rejection Ratio (CMRR) of the amplifier. In this circuit the equal voltages induced in the two leads are cancelled out by the equal gains and opposite signs produced by the plus and minus OP AMP input terminals. The desired signal from the transducers, being a difference voltage, is not cancelled and is amplified as required by this circuit.

So with today's OP AMPs featuring CMRRs of 100,000 (usually expressed as 100dBs) or so, the problem is solved—or is it? Well, no actually. That 100 dB figure is not easily attainable in a practical differential OP-AMP circuit because balancing the inputs correctly would call for *exact* values for the four resistors and that is not possible using ordinary 5% types. Even if very expensive 0.1% resistors are used, you will still not achieve anywhere near 100dBs, and there is another problem inherent in such a simple circuit, the low input impedance which is set by the resistor values, and which is unlikely to get much above 10K ohms for 741 type OP AMPs.

If the lowly 741 and four resistors was not good enough, in the past you had to turn to a highly expensive "Instrumentation Amplifier," originally available in module form and more recently produced in the form of thick or thin film hybrids which while certainly being smaller, are still expensive. The Instrumentation Amplifier circuit traditionally uses three OP-AMPs with two in the high impedance non-inverting configuration dedicated to each input and the third acting as the differential stage to give a ground referenced output. This configuration has a very high input impedance and excellent CMRR, but is difficult to make with, say, three 741s because resistor tolerances are still a problem. That's why you may not have heard of Instrumentation Amps, until now you have had to do without their special advantages because of their cost! But not for long thanks to

National Semiconductor and their LM363 which is a true Instrumentation Amplifier on a Monolithic chip costing a fraction of earlier designs. The LM363 comes in a tiny 8 pin TO5 can and needs no external resistors for correct operation because you buy the gain you need built in—10, 100, or 500 versions are currently available but soon there will be a 16 pin DIP version with gains selected by strapping pins. The 363 offers a 120dB CMRR and a super high input impedance requiring only 2 nano amps of input bias current.

DMOS REGULATOR

In the field of voltage regulation, there seemed to be hardly any frontiers left for regulators to conquer, but Texas Instruments have decided to tackle one of the few remaining with a new device which is designed to work at a much higher input voltage than has ever been possible before. Their new TL783 device is a positive output adjustable three terminal device which is able to operate with an input-output voltage differential of up to 125 volts! Until now, most adjustable regulators could manage only 40 volts, but by a clever combination of their bipolar and DMOS FET technologies Texas have shattered the high voltage barrier with a single low cost monolithic chip which will also deliver up to 700 milliamps provided that the voltage-current product does not exceed 20 watts. High voltage circuits are notorious for their short term transient conditions which could cause the Safe Operating Area (SOA) of a regulator to be exceeded leading to burn-out due to local hot spots, or even so-called secondary breakdown in the power devices used. The designers of the TL783 have not ignored these problems and have built in two separate protection systems to make the device virtually indestructible. A thermal protection system will shut the TL783 down if the chip temperature climbs too high, and a current limiter ensures that the 20W rating is not exceeded even under transient conditions.

Voltage regulation is good, with input voltage changes causing output changes of less than 0.02% per volt and load current changes causing only a 0.5% change in output voltage. Due to the DMOS series pass device however, the minimum input-output voltage differential is higher than usual, 10 volts at 400mA.

HIGH SPEED CMOS

When RCA first introduced its 4000 series CMOS logic in 1969 it became an instant success because for the first time it was practical to power a logic system from batteries. Despite the attractions of the

4000 series however, I could never quite understand why RCA had decided to use different pin-outs and logic functions to those in the then standard 74 series TTL family. Later, when National did the right thing and brought 74C series CMOS with TTL pinouts, I felt sure that RCA's 4000 series would soon be superseded, but I was wrong!

The 4000 series was soon established as the premier CMOS family and was second sourced by many other manufacturers, including National, while the family which I had backed languished in the wings waiting for its big moment to come. With the huge and growing family of 4000 series MSI parts it often seemed that the more humble 74C range would never make it, but now thanks (paradoxically) to microprocessors 74C is back with a vengeance. The trouble is, 4000 series and 74C devices have never been very fast, and that has not gone very well in microprocessor circuits where LSTTL has of necessity been the standard logic family—until now. With increasing pressure for faster and lower power microprocessor circuits the time is now ripe for a new fast CMOS logic family to provide the nuts and bolts of microprocessor systems, and since these systems are currently hooked on LSTTL the pinouts of that family are a must for a new CMOS series.

In a bold move, National and Motorola are both introducing a new family of fast CMOS parts with TTL pinouts—The 74HC series. The part numbers in this series will sound familiar to all TTL users, 74HC00 quad nand gate, 74HC74 dual D type flip-flop, 74HC245 octal bus transceiver, and so on, but ever mindful of the momentum in the 4000 series following, National and Motorola have hedged their bets by also including devices such as the 74HC4002 quad nor gate which has a 4000 series pinout!

This new initiative is bound to succeed, because these devices will be able to replace not only LSTTL but also 74C and 4000 series CMOS by having the twin virtues of high speed *and* very low power consumption. Take the 74HC00 for example, it will switch in 10 nanoseconds, the same as 74LS00, and very much better than the nearest equivalent 4000 series part the 4011, which needs about 100 nanoseconds at five volts. As for power, well the 74HC00 takes about 12 microamps from a 5 volt supply at 10kHz as against 8 microamps for the 4011 and 1.2 *milliamps* for the 74LS00. These specs mean that you can plug 74C devices directly into 74LS sockets to save power, or into 4000 sockets to speed things up.

Function Generator

ANDY FLIND

IN the electronics workshop an almost indispensable item of equipment for any type of work is a source of suitable test signals. For audio and low frequency work, the function generator is becoming increasingly common as the source of these signals since the choice of three output waveforms, sine, square or triangle, can be used to check the performance of almost any type of circuit encountered.

A major contribution to the popularity of this type of generator was the introduction a few years ago of the 8038 waveform generator chip. This device is now virtually an industry standard, and is used in many commercially produced generators costing eighty pounds or more. However, it's possible to construct an excellent instrument for about a third of this cost. Several designs have already appeared in the hobby press, but most of these so far have been based on the fairly simple circuit provided with application notes for this chip. This circuit works but it does leave a certain amount to be desired in terms of performance; for the instrument presented here the best possible performance from the 8038 was sought at the expense of a little extra circuit complexity.

CIRCUIT

From the designers' point of view the 8038 is a versatile device, but it might be said that it's a little unfinished. For a start, the three outputs are at different voltage levels and are sourced from medium to high impedance. Most designs employ a single amplifier to buffer them, the gain being varied by the function selector switch, but due to the high impedance levels this leads to some deterioration of performance at higher frequencies, especially in the case of the

SPECIFICATION

Frequency Ranges:

1-10Hz
10-100Hz
100Hz-1kHz
1-10kHz
10-100kHz

Ranges cover approx. 0.5 x lowest value to 1.1 x highest value of nominal range

Output Waveforms:

Sine, square and triangle.
Separate sync output of 16V p-p square wave available to drive scope timebase, frequency meters, etc.

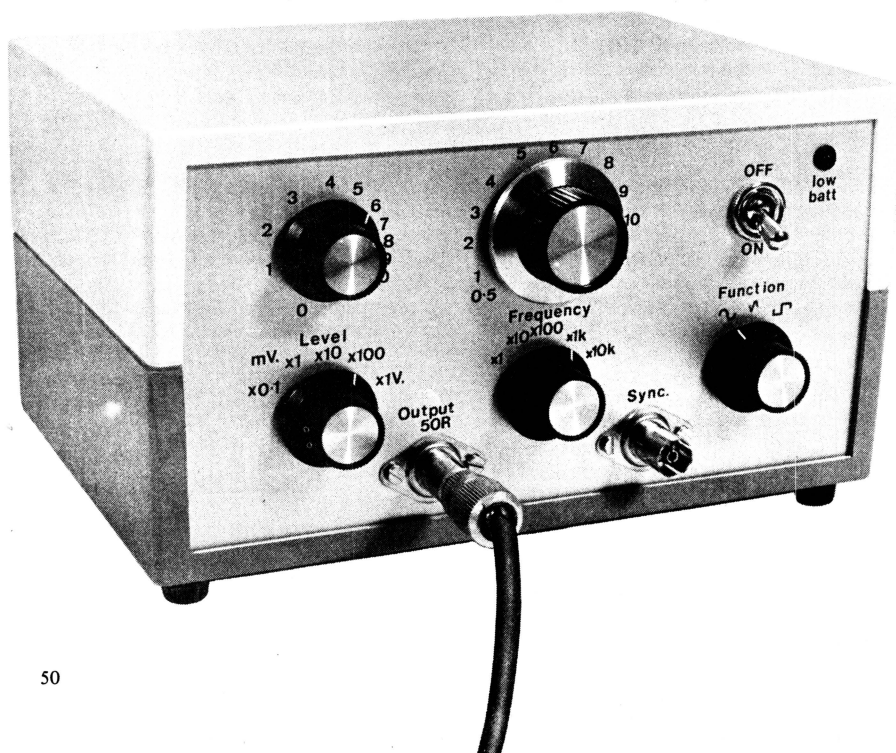
Main Output Ranges:

0-0.1mV
0-1mV
0-10mV
0-100mV
0-1V

Output source impedance is constant 50 ohms at all settings

Distortion:

Sine wave, better than 1% THD
Triangle linearity, better than 1%
Square wave rise time, approximately 100ns



Provides sine, square and triangular output waveforms

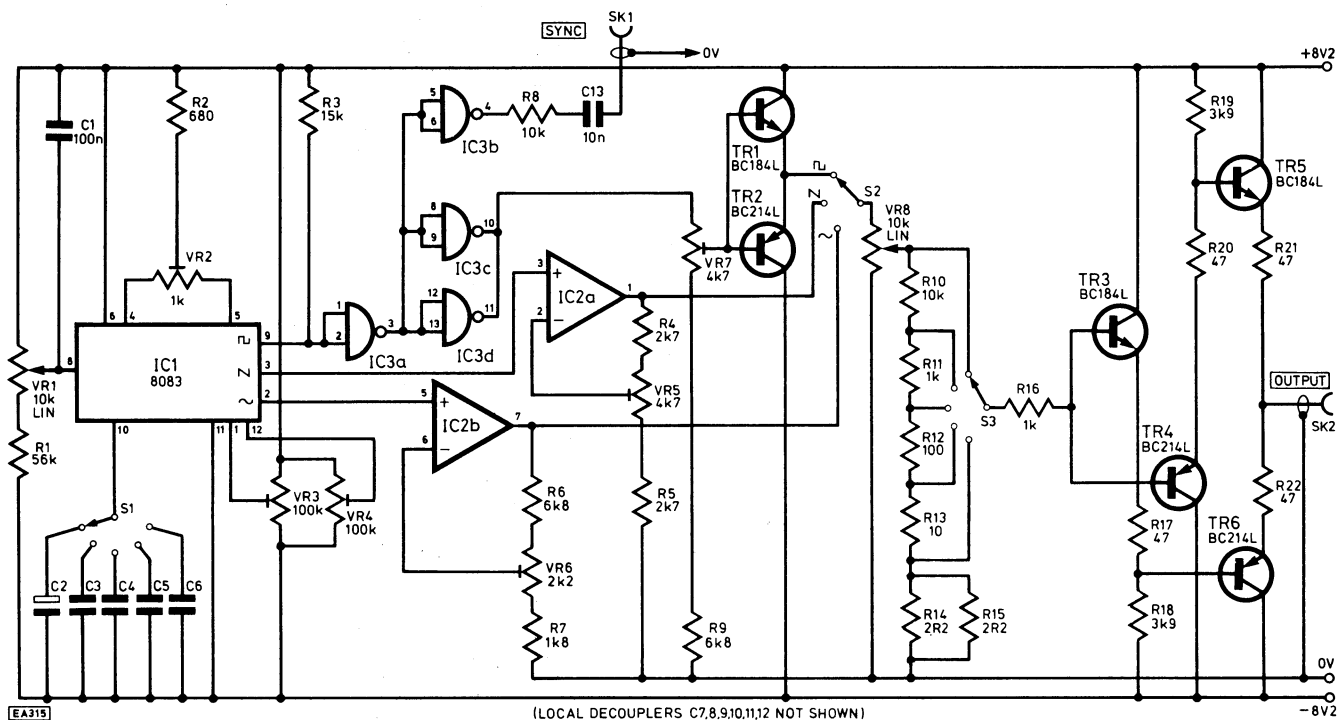


Fig. 1. Circuit of generator

square wave. To avoid this problem this design uses separate buffer amplifiers to bring the three outputs to the same voltage level and convert them to low impedance. Fig. 1 shows the complete circuit of the instrument. The triangle and sine are processed by amplifiers IC2a and b, their levels being adjusted by VR5 and VR6. The squarewave is taken from the open collector of a transistor in the chip, hence the need for the pull-up resistor R3, and is handled rather differently. A CMOS quad NAND gate chip, IC3, is employed here. The first gate "a" buffers the output and improves its switching time. Gate "b" provides a completely isolated sync output, useful for driving external monitoring equipment, such as synchronising a scope timebase via an external trigger input, or coupling to a frequency meter. Gates "c" and "d" are connected in parallel to drive level adjuster VR7, and the output is then buffered to low impedance by TR1 and TR2.

The initial levels of all the waveforms in this design are set to 10V peak-peak. The component values given in some other circuits have been selected to give approximately equal r.m.s. amplitude outputs; however this results in wide differences in the peak-peak values of the three waveforms. As an instrument of this type is generally used in conjunction with an oscilloscope calibration for equal peak-peak values seems more suitable.

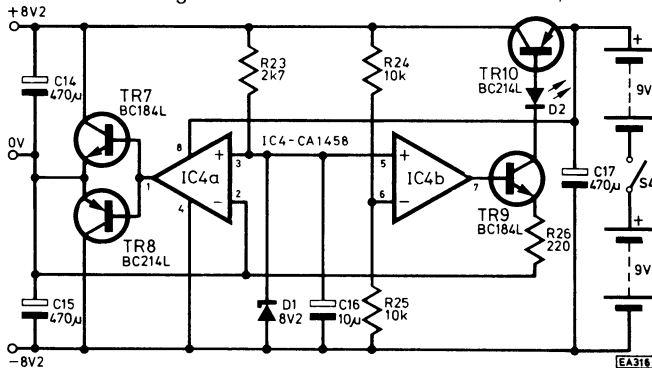
After buffering the required waveform is selected by switch S2 and passes via the "Fine" level control VR3 to the decade attenuator network and "Coarse" level selector switch S3.

The output stage consists of a discrete complementary emitter follower circuit, offering low noise, good small-signal handling ability, excellent high frequency response and a constant output impedance of 50 ohms.

The power supply section of the circuit appears in Fig. 2. A battery supply was chosen for this project as it provides portability, complete safety, and avoids the problems of hum and noise, etc., which might occur at low output levels if a mains supply were to be employed.

CONSTRUCTION

With the exception of the timing capacitors, attenuator resistors and the "low battery" i.e.d., all the components used in this project are mounted on a single printed circuit board. The component layout appears in Fig. 4, and the copper foil pattern in Fig. 5. Construction of this board should prove straightforward provided reasonable care is taken to ensure correct orientation of diodes, transistors, i.c.s and electrolytics. IC1 is a bipolar device and thus needs no special handling care, but the usual precautions should be observed for the CMOS IC3. Sockets can be used for the i.c.s if preferred. Suitable lengths of wire should be soldered to the completed board ready for connections to the controls etc. The use of ribbon cable here will produce a tidier finished assembly. It's a good idea to test the board before continuing. One of the timing capacitors can be connected to the leads intended for S1, and the appropriate leads can be shorted together to connect each buffered signal in turn directly to R16—there's no need to have S2, VR8, S3 and the attenuator in circuit for this test. VR1 and the i.e.d. should also be temporarily connected, and all the presets should be set to mid-travel. If an 18V supply is now applied to the battery connections the circuit should operate. The overall drain ought to be somewhere around 30mA, and the



supply voltages from the regulator should be checked with a meter across C14 and C15. The output can be checked on a scope, or with headphones, providing the value of timing capacitor selected gives signals within the audio range.

The front panel layout can be seen from the photograph. Wiring to the panel should be kept short and neat; some of the connections between the controls can be carried out before the panel is installed. The switches S1, S2 and S3 are 2-pole 6-way types with adjustable stops to allow them to be set to the number of ways required. Unwanted tags are cut off to prevent confusion during wiring. The resistors used in the attenuator are 1% thick film types; the cost of the extra precision amounts to only a few pence.

The nominal values of the timing capacitors are as follows: C2–10 μ , C3–1 μ , C4–100n, C5–10n, C6–1n. Most of these values are not easily obtained in close tolerance, so if the frequency control calibration is to be reasonably accurate they will have to be selected by trial and error using a frequency meter. With C6 stray capacitances become significant; on the prototype a bunch of small polystyrene capacitors totalling about 820p gave the desired results. C3, 4 and 5 can be polyester or polycarbonate types, different specimens can be tried until adequate results are obtained. 10 μ is not readily obtained as a non-electrolytic, so a tantalum bead was decided upon for C2. These are usually higher than their stated value; of a batch of five tried on the prototype all gave too low a frequency. A pair of 4 μ 7 tantalum beads in parallel instantly produced the correct range however, so this appears to be the best approach. With reasonable care over capacitor selection the output frequency can easily be within $\pm 5\%$ of dial settings over the entire range of the instrument.

The overall internal layout can be seen from the photograph. The p.c.b. is screwed directly to the pillars provided in the Verobox and the two batteries are held firmly in place with a short length of "Dexion" angle; a bracket made from sheet metal could be used instead.

SETTING UP

Adjustment of the presets is obviously easier if a scope is available, although it can be carried out reasonably well with a good quality analogue (not digital) voltmeter. Begin with VR2, which adjusts the mark-space ratio. This must be as close as possible to 50–50, at which point the average d.c. output will obviously be zero. Set VR8 and S3 for minimum (zero) output and check the output voltage with a meter; it may be zero, but if a small offset exists due to mismatches in the output transistors etc., note its value. Then select squarewave output at 500Hz and full amplitude, and carefully adjust VR2 until the same output d.c. value is obtained.

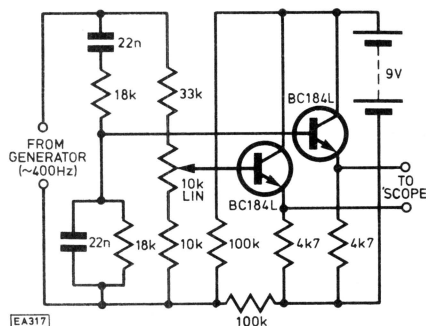


Fig. 3. Filter used when adjusting VR3 and VR4 (sine purity) potentiometers

The sinewave linearity pots VR3 and VR4 should be set next. A scope is an absolute "must" for adjusting these, if access to one cannot be obtained omit these two pots. Connect IC1 pin 12 to the negative supply via an 82k resistor and leave pin 1 open circuit. This will give quite acceptable results but an improvement can be obtained with correctly adjusted presets. Begin by monitoring the sinewave output at about 400Hz and adjusting VR3 and VR4 until the output looks reasonably sine-shaped. Quite good results can be obtained visually, but for the absolute optimum the circuit of Fig. 3 should be temporarily constructed and used to assist the process. This consists of a Wien Bridge filter with a pair

COMPONENTS...

Resistors

R1	56k
R2	680
R3	15k
R4, R5, R23	2k7
R6, R9	6k8
R7	1k8
R8, R24, R25	10k
R16	1k
R26	220
All 5% $\frac{1}{2}$ W carbon	
R10	10k
R11	1k
R12	100
R13	10
R14, R15	2-2
R17, R20, R21, R22	47
R18, R19	3k9
All 1% thick film	

Potentiometers

VR1, VR8	10k lin. carbon	} Sub-min horizontal presets
VR2	1k	
VR3, VR4	100k	
VR5, VR7	4k7	
VR6	2k2	

Capacitors

C1, C8, C9, C10, C11, C12	100n ceramic disc
C2, C3, C4, C5, C6	see text
C7	47 μ 25V electrolytic
C13	10n polyester
C14, C15, C17	470 μ 25V electrolytic
C16	10 μ 25V electrolytic

Diodes

D1	BZY88C8V2 8-2V 400mW Zener
D2	sub-miniature, red l.e.d.

Transistors

TR1, TR3, TR5, TR7, TR9	BC184L
TR2, TR4, TR6, TR8, TR10	BC214L

Integrated Circuits

IC1	8038 waveform generator
IC2	CA3240E
IC3	4011BE
IC4	1458C

Miscellaneous

S1, S3, single pole, 5-way; S2, single pole, 3-way; S4, single pole, single throw; Case, Vero type 202-21036G, 205 x 140 x 110mm; Output sockets, BNC or coax, surface mounting; battery clips, p.c.b. materials, control knobs, ribbon cable.

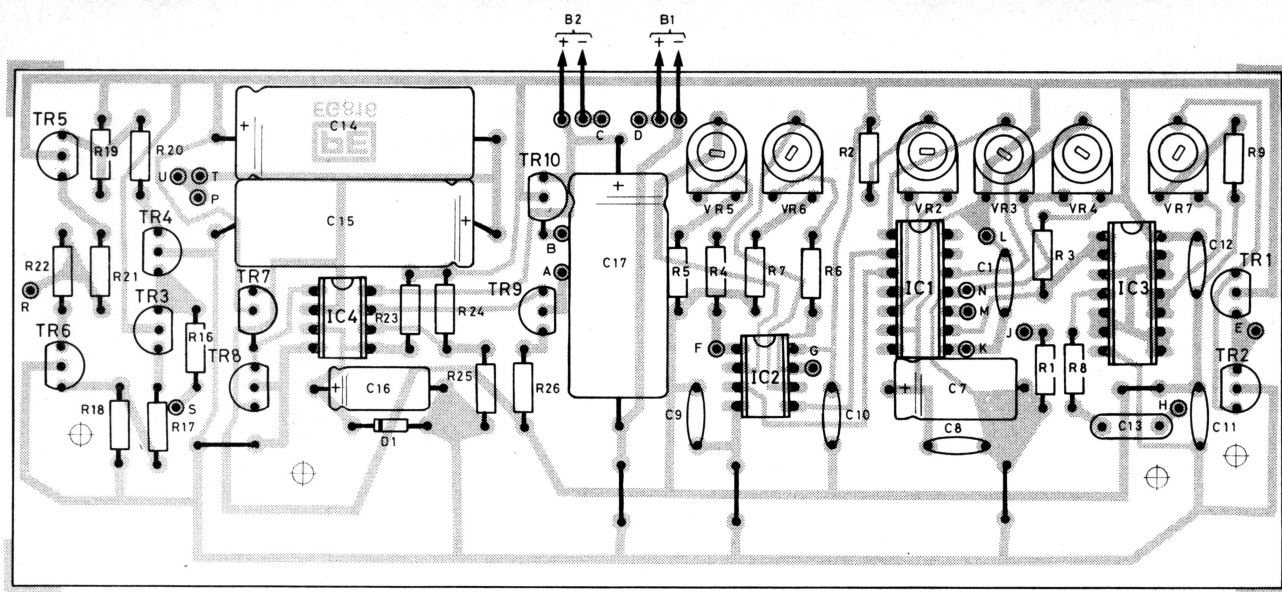


Fig. 4. Component layout of board

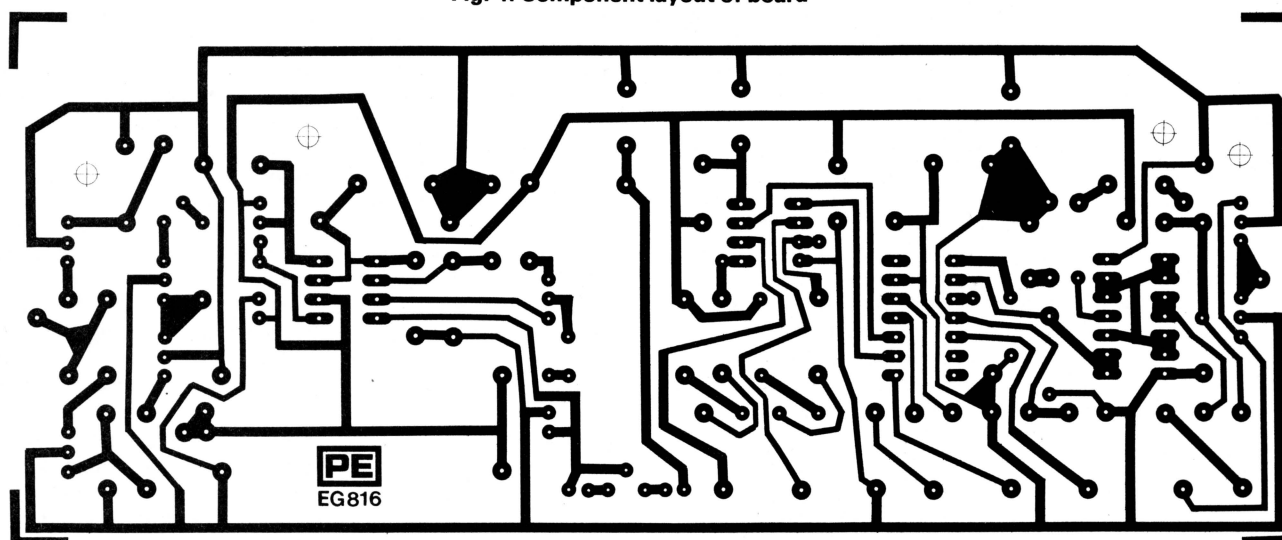


Fig. 5. Printed circuit

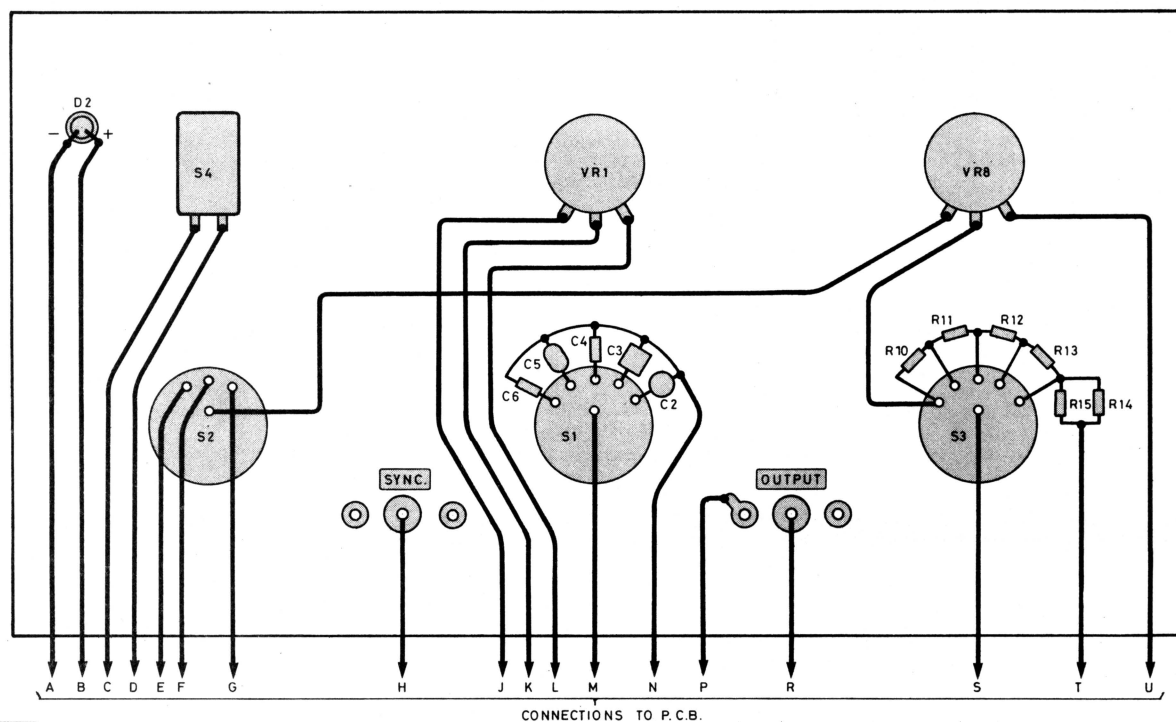
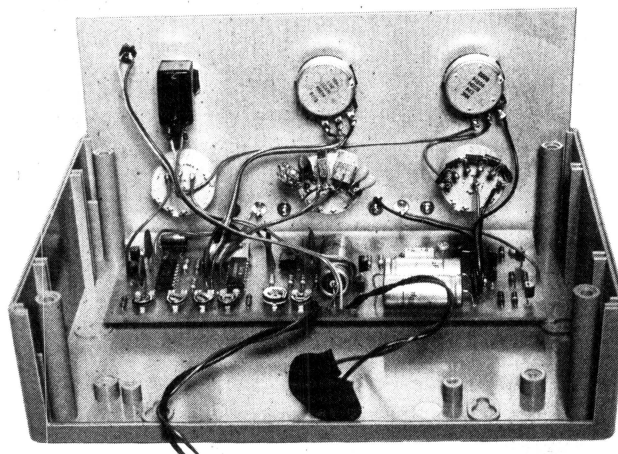
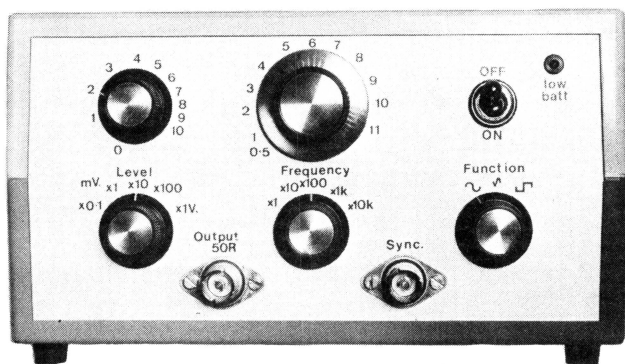


Fig. 6. Control panel assembly showing leads connecting to Fig. 4



of output buffers, and it will completely remove the fundamental sine wave at about 400Hz, leaving only the distortion components. The 10k pot should be used in conjunction with the generator's frequency control to obtain the deepest possible null; the residual signal still visible will then consist almost entirely of harmonics and VR3 and VR4 can be adjusted to reduce this as far as possible.

This leaves VR5, 6 and 7, respectively the triangle, sine and squarewave output level adjusters. If your scope will monitor the output voltage accurately they can be adjusted to give 10V peak-peak maximum output for each waveform. This adjustment can be made with a meter however, if a 470 μ capacitor is temporarily connected across one of the timing capacitors. This will slow the output frequency down so much that it can be accurately monitored with the meter; note that 10V peak-peak means 5V peak either side of zero!

Calibration of the "Fine" frequency control VR1 will require a frequency meter, but the calibration of VR8 can be carried out easily with a meter if the frequency is slowed as above and the squarewave output is used. Note that the action of VR8 is not linear owing to its slider being loaded by the attenuator chain, but the calibration of VR1 should be linear across its full range.

USING IT

This instrument has been designed to be as quirk-free as possible. In general its frequency and voltage output should be within 5% of that set on the controls; there are no

problems such as change of amplitude with frequency etc., and the waveforms, including the squarewave, remain excellent all the way up to 100kHz. Perhaps the only failing is some breakthrough of the squarewave into the sine and triangle at the lowest output range (0–1mV). If really low levels are required it may be advisable to use a higher level and place an attenuator at the input of the circuit under test. The lowest output purity is quite adequate for most purposes though, hence its retention in the design.

The circuit is d.c. coupled throughout to avoid distortion at very low frequencies. Due to component tolerances, non-linearities in the chip etc., there may be a small offset voltage on the output (a few millivolts); also the output will not take kindly to large d.c. voltages placed across it from the equipment under test, so remember to use an isolating capacitor where necessary. Both sync and main outputs will withstand short circuits without damage, although prolonged short circuiting of the main output is not recommended.

The generator is intended to work into impedances of 1k or greater but in fact has enough power to produce sound from 8 ohm loudspeakers, at reduced voltage of course due to the 50 ohm output impedance. Note that working into low impedance reactive loads will distort the waveform. ★

BAZAAR

SALE of Practical Electronics from very first issue. Will sell individually or the lot. Tel: 01-529 0612.

LAMBRA Compudialer 749 complete with mains adaptor, £30. Also AP25 Linear Amp £15. Mr. P. Thompson, 46 The Stirrup, Stroud, Gloucestershire. Tel: 045-36 5918.

8K PET small key-pad model £300. Tel: Sheffield 386402.

WANTED: obsolete British transistors EW, GET, WKT, V, series, etc. Circuit cards welcome. Write for offer. Mr. A. Wylie, 18 Rue de Lausanne, 1201 Geneva, Switzerland.

SWAP b/new TR7800 and AR240 complete for FT220 FT221R TS7005 P. Turner, 51 Weyland Road, Ipswich IP6 9ET.

AIRMEC signal Gen., 30kHz–30MHz £12, pair PYE PF1's, stalled for RB14, modded for PP3's, £20. Michael Gathergood, G4KFK, 80 Moorfield Road, Denham Green, Uxbridge, Middx. UB9 5NF.

SINCLAIR multimeter (digital) DM1; working fine, but case slightly damaged near switches. Most interesting offer secures. Laurence Cook, 7 Plum Tree Close, Ecclestone Park, Prescott, Merseyside L35 7JT. Tel: 051-426 5138.

ATARI computer game console, controllers, mains adaptor, £75. Chess £25. Invaders £20. Basketball £10. Tel: Rayleigh 747845.

OSCILLOSCOPE CT52 in original carrying case, great condition £40 or W.H.Y? buyer to collect. John Sartorius, 52 Caulfield Drive, Greasby, Wirral, Merseyside L49 1SW.

SALE Sharp portable radio air 108 136 MHz MW 520 1620kHz, £11, including post & packing. Mr. K. Mealor, 38 Bishopgate Street, Liverpool L15 1EW.

500 American radio magazines perfect condition £20. Collectors items, Radiolympia catalogues, American radio catalogues, offers, collect. L. Marks, 14 Avenue Road, Kingston, Surrey KT1 2RB.

SUB-MIN relays 15K & 700R Ex-eqpt, cased with sockets & clips 2P C/O contacts, 75p each + p.&p. D. Woolcock, 33 Bank Place, Ashton, Preston, Lancs. PR2 1DN.

INSTRUCTIONS wanted on loan to copy—Telequipt D43 oscilloscope—147 George Road, Edington, Birmingham.

NASCOM 1 cased PSU16K board P.I.O. sound zep and Napsen on tape manual, offers. Tel: Great Yarmouth 0493/55622.

CASED Superboard, expansion board, p.s.u., Cassette recorder, and software £95. Data Dynamics 390 RO printer £85. Mr. R. W. Hearn, 10 Speedwell Close, Pakefield, Lowestoft, Suffolk.

OHIO Superboard 8K 32 x 32 display. 1200/300 Baud cassette 1.5MHz. Smartly cased. Software inc. asteroids assembler £165. Tim Groves, Burnham-on-Sea. Tel: 0278 785845.

BI-PAK 2240 teak amp cabinet chassis sockets facia knobs new ½ list price £10 plus carriage. G. A. Noble, 50 Croft Hill Road, Slough, Berks. SL2 1HF.

WANTED: Hewlett Packard model 33 teletype spares. Anything considered. Send any information to: Nicholas Belson, 20a Furzedown Road, Highfield, Southampton.

40K UK101 10K Basic Cegmon interface boards, assembler editor £425 o.n.o. SAE details or phone evenings. Simon Riddle, 51 Marshalwick Lane, St. Albans, Herts. AL1 4UT. Tel: 0727 53946.

CLEF PE Master Rhythm as new 01-578 5448, £70.

SINCLAIR DM2 3½ Digit bench type multimeter with mains adaptor £25. Phone evenings (Liskeard) 0579 43749.

SUPERBOARD 8K and 8K plus case, p.s.u. and programs £150 o.n.o. Alan Biase, 041-637 8897 (Glasgow).

UK101 Speech synthesiser. Plugs into PE's Decoding Module. Infinite vocabulary, sample software, smart case. Only £55. Mr. P. Coates, 94 Haddington Road, Whitley Bay, Tyne & Wear. Tel: 0632 513887.



SIX MOONS FOR SATURN

Further examination of the Voyager data indicates from the imaging processes that there are definitely four more moons to add to the satellites of Saturn and the possibility of two more yet to be confirmed. A member of the research team S. P. Synott found an object 217mi. from Saturn between the orbits of the satellites Tethys and Dione. He found another at a point about 60deg. preceding the satellite Dione. Synott also found a third and fourth companion of Tethys in what he termed a horseshoe orbit but they were at the limit of resolution. Still another possible satellite was observed as a streak in a Voyager photo. The indication in this case was that the object was about 219000mi. from Saturn and between the orbits of Dione and Rhea.

Together with R. Terrille, Synott also found a new satellite at about the same orbital distance from Saturn as its satellite Mimas. This object was identified previously from the data of the Voyager 2 charged particle detectors. It is estimated that this satellite is about 6 miles in diameter. The rest of the other new satellites would seem to have possible diameters which lie between 9 and 12mi.

ARIEL VI SWITCHED OFF

At the end of February 1982 the UK/ARIEL scientific satellite was switched off according to programme and the ground station at the Rutherford and Appleton Laboratory shut down. The history of the achievements of itself and its predecessor Ariel V has been outstanding. Not only is the data extensive but also far greater than the original design programme. The team at the RAL, were almost a small family group, so integrated with each other that they were able to anticipate conditions and act so that the gas for attitude control lasted far beyond the expected period. Many subtle ways of handling the management have been the means of bringing forward data of great value.

The final scientific experiments were carried out between the 8th and 19th of February.

The satellite spin rate has now been reduced to such a low level as the result of aerodynamic drag that it is not possible any longer to make stable scientific experiments. Previously there had been two successful 'spin-up' manoeuvres thus prolonging the life of the satellite.

Ariel VI was the last in the series of the Science and Engineering Research Council experiments. Four Universities were involved together with the Royal Aircraft Establishment at Farnborough. The Universities were Bristol, Leicester, Birmingham and University College. The contributions of experiments were:

—Cosmic-ray Detector—Bristol University.

—Two X-ray Experiments (Astro-nomical)—Leicester and Birmingham jointly with the Mullard Space Science Laboratory of University College.

—Two Technology Experiments—RAE Farnborough.

Very substantial scientific results have been achieved. The Bristol University cosmic-ray equipment has provided, for the first time in a single exposure, observations of the ultra-heavy cosmic-ray particles throughout the entire range of the elements from Iron to Uranium. A number of surprising features have been brought to light in consequence. To name one, it was found that there is a striking OVERABUNDANCE of elements with charges between 58 and 72. This implies that there is an overabundance of ultra-heavy particles in the cosmic-ray source regions. When taken together with the abundances over the whole of the remaining charge range this will enable a greater understanding of the mechanism of cosmic-ray production and the acceleration.

The X-ray experiments have also been extremely successful. In the Leicester Experiment which was designed primarily to follow up the results of observations by Ariel V 30 X-ray sources have been studied in great detail. Special note here is due to the very effective spectral and variability data for several of the Black Hole candidates and a determination of the rotation periods of a number of accreting Neutron Stars. The examination of several quasars and Seyfert galaxies has revealed the presence of strong Iron emission. This leads to the conclusion that there is an abundance of the heavy elements in the gas surrounding the nucleus. Also the emission spectra in the nuclear regions show very high temperatures. Simultaneous optical and X-ray observations have been carried out.

The low-energy X-ray telescope provided by Birmingham University and University College London was designed to explore a relatively new region of the spectrum. Results here include a study of twenty sources in detail. One of these was Cygnus X2. This has been shown to contain a White Dwarf star: an unexpected result since Neutron Stars are usually involved in the production of X-ray stars in binary systems or in star pairs.

Line emission has been detected during a stellar flare in Ursa Major (the Great Bear). This will be an opportunity to permit examination of the gas heating process. In addition to all this, a major study of diffuse X-ray emission from the sky was made.

With the success however there were

problems. One example was spurious switching, which was thought to be from ground based sources, of the sub-systems such as high voltage supplies and the on-board recorders; large scale temperature excursions during periods of full sunlight; a slow degradation of the battery voltage with protracted recovery times and anomalies in the on-board sensing system producing significant errors in pointing. However, in spite of these difficulties Ariel VI was kept in operation by the concentrated effort of all those concerned. One of the major means of keeping up the flow of data was by means of a portable ground station set up by University College at a site near Canberra, Australia, and a ground station at the Italian San Marco Station in Kenya. By these means the satellite has twice been able to extend operations beyond the original 2 year design.

The satellite was launched on a NASA scout vehicle from the Wallops Island complex at Virginia, USA. The contract for the design and development of the satellite was carried out by Marconi Space and Defence Systems, Portsmouth and the manufacture of the satellite structure and mechanism sub-contracted to British Aerospace at Bristol.

INTELSAT 6

Negotiations are going on between International Telecommunications Satellite Organisation and Hughes Space and Communications Space Group for the construction of a series of Intelsat communications satellites.

The design submitted would cost about 1 million dollars for each vehicle. The dimensions are 11.8 feet in diameter and 37 to 38 feet in height with a weight of the order of 7,700lbs.

LUNAR ORBITING LABORATORY

The European Space Agency has revived the studies for a Lunar Orbiting Observatory in place of the United States European cooperation Moon project which had to be abandoned because of US fiscal problems. Europe had already seriously discussed the move to 'go it alone'. A number of concepts are being considered for an all European. Moon observation project.

One proposal for the mission calls for the Max Planck Institut and AMSAT the Amateur Satellite Corporation, to develop a lunar relay satellite under German Government funding. The relay craft would provide tracking/relay functions when the mission's primary orbiter vehicle is over the far side of the Moon. The original Polo mission plan was envisioned as a spin stabilised satellite to be placed in high orbit. The large primary orbiter would be three axis stabilised and would operate from a lower lunar orbit. Decisions will have to be made by the end of the year if it is to be in the 1980's programme.

DISCO MISSION

The European Space Agency's Disco mission would investigate the Sun's interior by measuring global oscillations in the visible spectrum and variations of the solar constant. The spacecraft would be launched by an Ariane launcher and flown to a place between the Earth and the Sun at the libration point. This is approximately 931,500 miles from the Earth on the Earth/Sun line.

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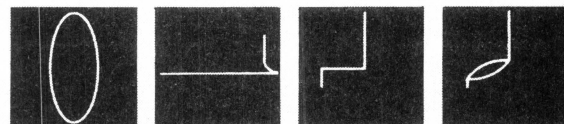
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STEREO CASSETTE DECK part 2

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THE p.c.b. design and the component layout for the Quasar are shown in Figs. 1&2. Take care with the orientation of the semiconductors and the electrolytic capacitors. After soldering recheck all the components have been correctly placed and remove any solder splashes from the copper side of the board.

The holes for the two wooden battens should be drilled and countersunk as shown in Fig. 3, alternatively if the correct adhesive is used screws will not be required.

Before fitting any components to the front panel temporarily fit the fascia panel legend to the front panel and using the front panel as a template cut the mounting holes in the legend using a sharp knife. Carefully remove the legend and fit the slider potentiometers and the two slider switches. Note the earth tag on the GNR switch.

The VU meter should be glued into position taking care that it is correctly orientated. The legend can now be fitted to the fascia panel using either glue or double sided tape. Once the legend has been fitted mount the combined recording bias and on/off switch (S4).

CASSETTE DECK

There are four mounting brackets to be fitted to the cassette deck as shown in Fig. 3. Take special care that the screw shown arrowed in the photograph is shorter than the others or the pause key will not operate correctly. The record/play switch (S1) should be fitted to the cassette deck using the bracket shown in the photograph opposite. Note the switch pins should be trimmed and then mounted with the cut pins nearest to the mechanism.

The two aluminium brackets should now be fitted onto the cassette compartment and the control keys also fitted with the record key fitted on far left.

The case should be drilled and SK1 and the two jack sockets (JK1) fitted. Also fit the fuse holder, C48, the tag strip and T1. Please note that the mains transformer must be placed as shown otherwise 'hum induction' will occur. If a different layout is used and space is limited a toroidal transformer must be used (18V sec. @ 0.5A).

Two pieces of tin foil are used on the front and side panels for screening purposes and these should be glued into position after the holes have been drilled. The front panel can now be inserted into the case and the case glued.

WIRING

The top of the cassette deck should be wired before it is installed into the case and the wiring clipped as shown. The mechanism can then be screwed into position and the

cables from the heads marked and routed through to the p.c.b. The p.c.b. should be wired first and then the components fitted to the pots and switches. After the unit has been wired recheck all the connections against the wiring diagram. The VU meter can be illuminated by connecting a 24V bulb across the secondary of the transformer and mounting it behind the meter.

When all the wiring has been checked the p.c.b. should be mounted under the cassette mechanism on the four pillars. The earthing method should not be changed from that shown in Fig. 3 otherwise 'hum loops' or 'hum pick up' will occur.

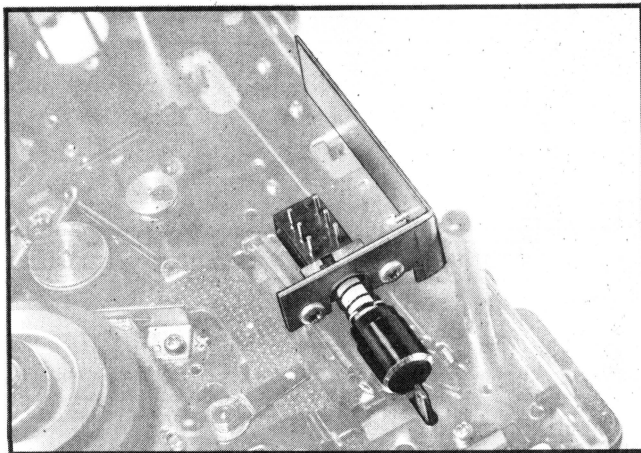
The backplate should also be fitted with tin foil and then connected to the earth tag on the transformer T1.

TESTING

Initially set the presets to the positions shown in Fig. 2 and then switch on the unit and measure the supply voltage on the p.c.b. The on/off switch is a push-pull type and the up position is on.

PLAY

With the GNR switch in the off position insert a pre-recorded tape and switch on the power. When the play key is depressed the system should be functional, if not switch off immediately and recheck the wiring. Assuming everything is OK then check the fast forward, rewind, pause and auto stop. With all the keys in the off position observe the signal to noise level and then turn the GNR switch to the



Mounting details of the record/play switch S1

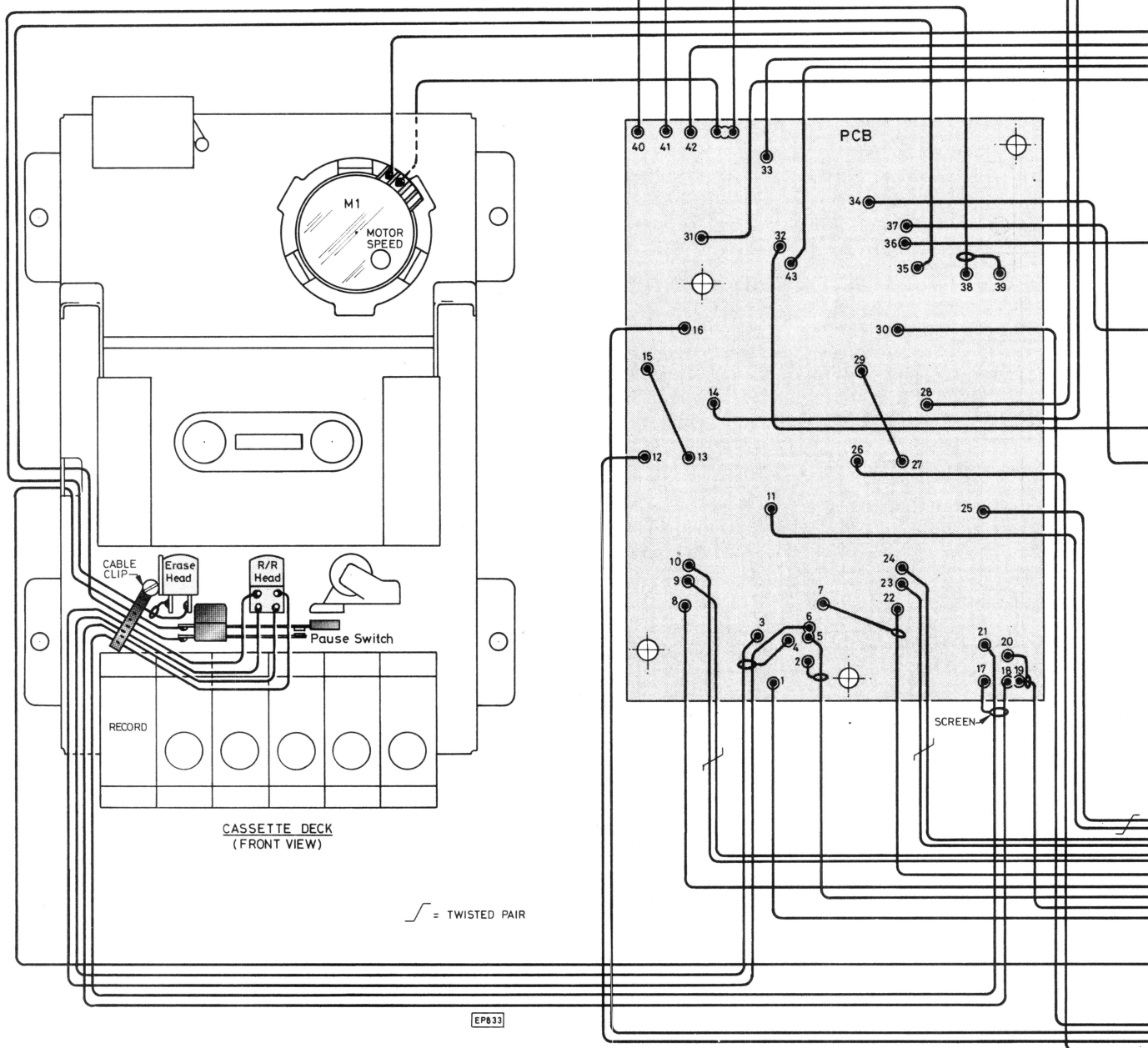
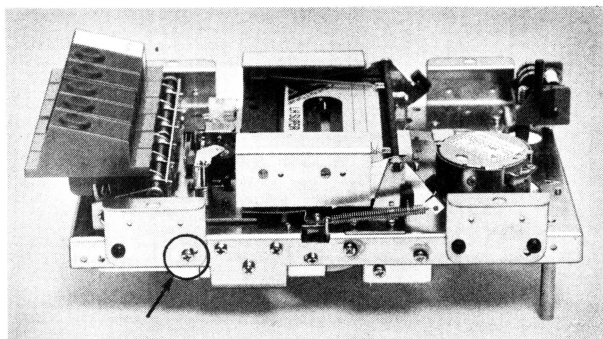
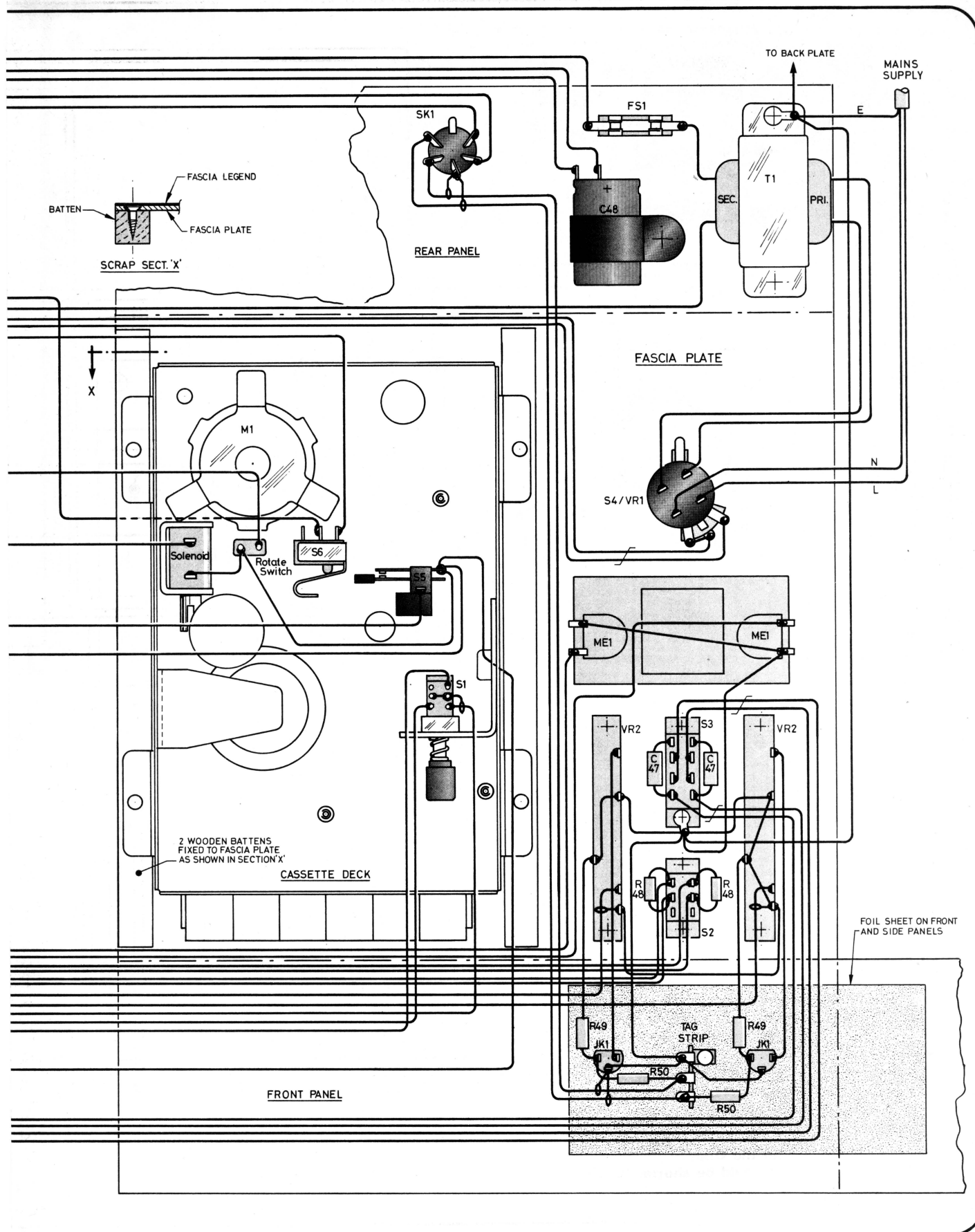


Fig. 3. Wiring diagram for the Quasar. Note the arrowed screw in the photograph should be shorter than the other bracket screws



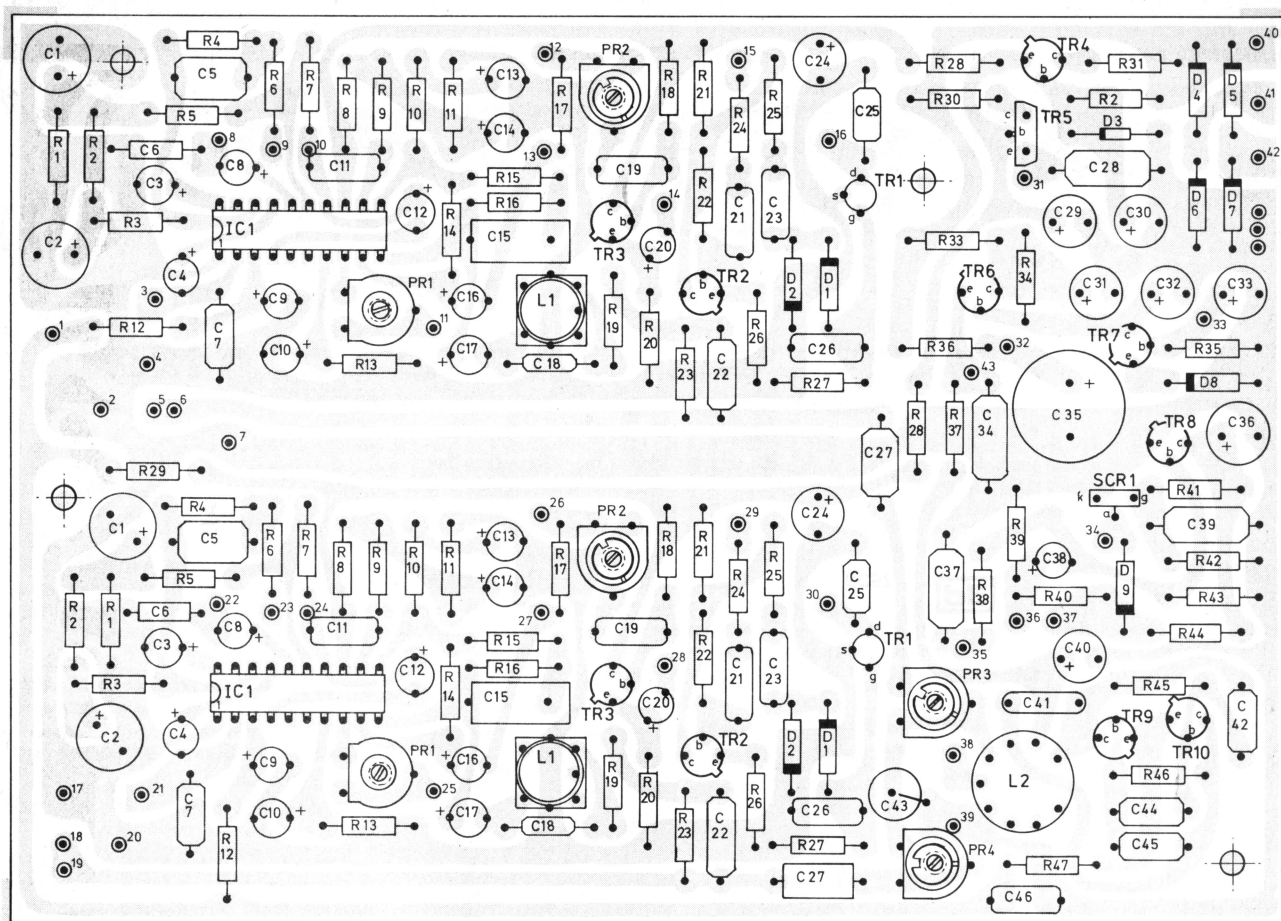


Fig. 2. Component layout

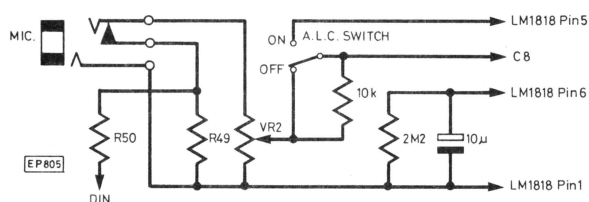


Fig. 4. Optional auto level control (ALC) switch circuit. The ALC circuit is shown in Fig. 4. The level controls should be set to maximum during ALC recording. Screened wires (connected at one end) should be used.

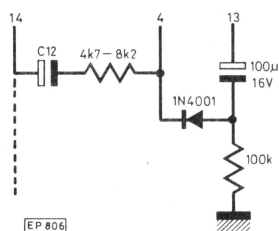


Fig. 5. Optional turn-on transient suppression for the meter/ALC circuit.

If additional meter suppression is required then the circuit shown in Fig. 5 can be used. The copper track between C12 and pin 4 should be cut and replaced with a 4k7 and 8k2 resistor. The other components can be "hung" between the

pins. Note: Depending on the value of the resistors used the meter/ALC drive sensitivity will drop. PR1 will require resetting.

If a signal generator is not available then the settings for the preset shown in Fig. 2 should suffice. A more accurate alignment of PR1, PR3 and PR4 requires a scope and audio generator. The presets PR3 and PR4 should be set so that the pk-pk voltage across the head corresponds to the markings around VR1 (a scope with low input capacitance, typically 20pF, should be used to obtain the correct level). The two meters are calibrated via the presets PR1 and with the tape set in the record mode feed a 30mV sine wave signal @ 1kHz into the DIN input. With the level controls at maximum adjust the presets to 0dB (the beginning of the red line on the meter).

The head wires and the record/play switch wires near the p.c.b. can be adjusted to cancel any 'hum' present.

If the DIN input/output socket is connected to an amplifier and the amplifier has no facility for switching off the 'tape output signal' positive feedback may result when the tape output signal level is high i.e. the signal from the tape recorder is amplified by the amplifier and feeds back into the input of the cassette. If this occurs set the level control to minimum during playback.

Should meter reading on record be encountered when there is no input signal check the screening is correct and the adjustment of L1. If the meter still shows a deflection fit a small screen over the top of the record/play switch. ★

MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus presents ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data. The most original ideas often come from readers working on their own systems; payment will be made for any contribution featured.

THIS MONTH'S Micro-Bus is dedicated to all the overseas readers of the column, and includes contributions for the ZX80 and ZX81 microcomputers from Iceland, Portugal, Sweden, and Hungary.

KEYBOARD CLICK

An ingenious circuit devised by *Peter Gudjonsson* of Iceland for the ZX80 or ZX81 eliminates the need to look at the screen when entering programs. It gives positive feedback in the form of an audible click every time a key is pressed. The circuit, shown in Fig. 1, uses a 74LS173 tri-state register to gate the keyboard strobe, line DI¹, into the gate input of a 555 timer. The components will fit onto a small stripboard which can be connected to the ZX81 via the backplane: see Fig. 11.

INVERSE VIDEO

The normal ZX81 display mode is black text against a white screen. However, *Antonio Joao Gomes Nunes* of Portugal has discovered a simple way of inverting the picture for people who prefer white characters on a black

Fig. 1. Circuit produces a keypress click on the ZX80 or ZX81

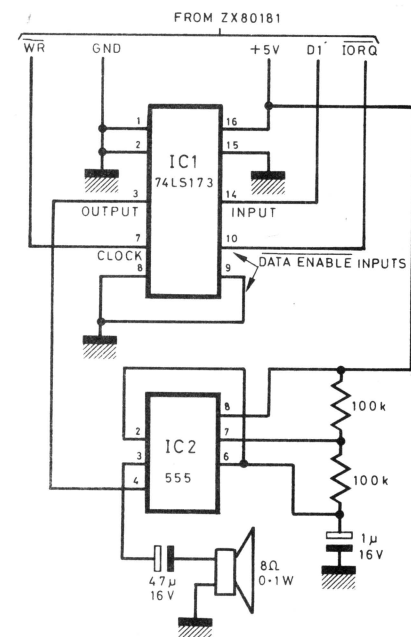


Fig. 4. Connection to the ZX81 modulator should be cut to add the Inverse Video circuit

screen: see Fig. 2. In the circuit, shown in Fig. 3, the first inverter inverts the video signal, but since it also inverts the TV sync. signals it is necessary to reconstitute them using the other two inverters and R1.

The circuit is connected between the video output of the computer and the UHF modulator, and to do this it is necessary to cut the UHF video input terminal (the one nearest the jack sockets: see Fig. 4). The circuit power supply can be obtained from the 0V and 5V connections on the backplane: see Fig. 11.



Fig. 2. ZX81 display produced by Inverse Video circuit of Fig. 3.

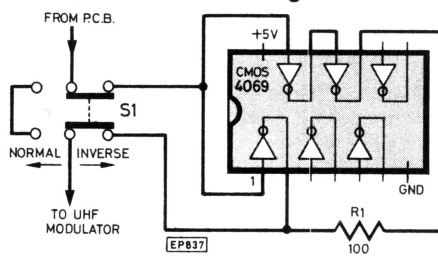
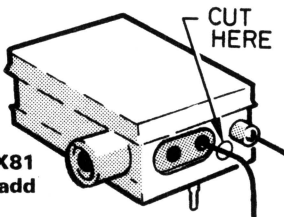


Fig. 3. Circuit inverts the display of a ZX81 to give white text on a black screen



ZX81 RENUMBER

A renumber program for the ZX80 was featured in last *November's* Micro-Bus. The following program, also submitted by Antonio Joao Gomes Nunes, performs the same function on the ZX81, though in a totally different manner. It finds the bytes containing the line number by PEEKing the bytes containing the length of the previous line, giving a faster and shorter program.

To use the program, first enter the program to be renumbered, and not all lines containing GOTO statements. Before entering the Renumber program perform the following direct command:

```
LET Z=PEEK 16396 + 256 *PEEK 16397 - 1
```

This sets Z to the address of the last byte in the program memory, for use in the renumber program. Now type in the program, shown in Fig. 5, and execute it by typing GOTO 9000. When the listing reappears amend all the previously noted references to line numbers in GOTO statements, and delete the Renumber routine.

The program works as follows: In lines 9400 and 9600 the pointer N is pointed to the next byte containing a line number by adding its value plus 3 to the PEEKed length of the line; it is then incremented in line 9600. The new line number L is POKEd into bytes N and N+1 by lines 9200 and 9300. As shown the program rennumbers starting with line 10 and with increments of 10, but this can be changed by altering lines 9000 and 9500.

```
9000 LET L=10
9100 FOR N=16509 TO Z
9200 POKE N,INT(L/256)
9300 POKE N+1,L-INT(L/256)*256
9400 LET N=N+3+PEEK(N+2)+256*PEEK(N+
9500 LET L=L+10
9600 NEXT N
9700 LIST
```

Fig. 5. Renumber routine for the ZX81

REACTION TIMER

The reaction-timer program of Fig. 6 was developed by *Silvestre Carmeiro* of Portugal to measure reflexes on his ZX81. The reaction time is obtained over a number of attempts, specified on first running the program a black bar appears in the centre of the screen the "P" key is pressed as quickly as possible, and the reaction time, in hundredths of seconds, is displayed on the screen. Pressing the "A" key then repeats the test. After all the tries are

completed the computer will print the average reaction time.

Lines 80 and 90 make the black bar appear after an unpredictable time (between about 0.1 and 15 seconds); the "*" characters in line 100 represent inverted spaces. Lines 110 to 140 form a clock to count the reaction time. If the "P" key is held down before the bar appears the program claims that cheating has occurred, and a reaction time of 4 seconds is added to the running total!

```

10 REM REFLEXES
20 RAND
30 PRINT "NUMBER OF TRIES?"
40 INPUT N
50 CLS
60 LET Y=0
70 LET Z=0
80 LET A=20*RND
90 IF INT A<>4 THEN GOTO 80
100 PRINT AT 10,14 "****"
110 POKE 16436,255
120 LET A$=INKEY$
130 IF A$<>"P" THEN GOTO 120
140 LET X=253-PEEK 16436
150 CLS
160 IF X<=4 THEN PRINT "YOU ARE CHEATING"
170 IF X<=4 THEN LET X=200
180 PRINT X*2
190 LET Y=Y+X
200 LET Z=Z+1
210 IF Z=N THEN GOTO 280
220 PRINT
230 PRINT "READY?"
240 LET B$=INKEY$
250 IF B$<>"A" THEN GOTO 240
260 CLS
270 GOTO 80
280 CLS
290 PRINT "MEAN REACTION TIME"
300 PRINT
310 PRINT INT(0.5+(Y/Z*2));" HUNDREDTHS"

```

Fig. 6. Reaction timer program for the 1K ZX81 measures reflexes over a number of attempts

ETCH-A-SKETCH

An Etch-a-Sketch program was featured in the January 1981 Micro-Bus. The version for the ZX81 shown in Fig. 7, devised by Anders Ljungfeldt of Sweden, not only allows diagonal movement, but also occupies less memory, thus allowing a larger drawing-board.

To start drawing press the "S" key, and the pixel at (35, 35) will appear on the screen. This is the top-right limit of the drawing board. The keys Q, W, E, A, D, Z, X, and C are used to draw up, down, right, left, or diagonally, according to the position of the key. The central key, "S", is used to shift between drawing and erasing.

```

10 LET A=35
20 LET B=35
30 LET U=1
100 PAUSE 400
110 POKE 16437,255
120 LET X$=INKEY$
200 IF X$="Z" OR X$="Q" OR X$="
A" THEN LET A=ABS(A-1)
210 IF X$="E" OR X$="D" OR X$="
C" THEN LET A=A+1
220 IF X$="Z" OR X$="X" OR X$="
C" THEN LET B=ABS(B-1)
230 IF X$="Q" OR X$="W" OR X$="
C" THEN LET B=B+1
240 IF X$="S" THEN LET U=U+1
250 IF INT(U/2) <> U/2 THEN GOT
O 320
260 IF A>35 THEN LET A=35
270 IF B>35 THEN LET B=35
300 PLOT A,B
310 GOTO 100
320 UNPLOT A,B
330 GOTO 100

```

Fig. 7. Etch-a-Sketch for the ZX81 gives cursor drawing on the screen

ZX81 COMPOSES MUSIC

A recent letter to Micro-Bus included a cassette of a very catchy tune, apparently played on an electronic organ. The accompanying letter revealed that the tune had been improvised by a program running on a ZX81, which was linked to a synthesiser by a simple interface. The idea was developed by A. A. Szalay of Hungary, and the following description is based on his letter.

SYNTHESISER INTERFACE

The circuit shown in Fig. 8 will interface a ZX81 to a standard 1V/octave analogue synthesiser. With the program to be described it can be used as a sequencer, and many more interesting ideas are possible.

The circuit uses output ports 3, 7, and 11 on the ZX81, to avoid any conflict with those used by the computer. The 4013 acts as a monostable, producing a trigger pulse long enough for the synthesiser. An R-2R resistor ladder is used as a simple D/A converter, and R should be chosen as at least 500K ohms to match the output resistance of the CMOS latches. The resistors chosen for the ladder should be matched accurately, and the following easy method is recommended: Obtain a pack of about 40 resistors, measure them, and arrange them in order of magnitude (a simple program on the ZX81 could be used to do this); the result should be a Gaussian distribution of resistances. For the 5 single resistors of value R choose the 5 resistors from the middle

of the distribution. Then for the 7 resistors of value 2R, connect in series 7 pairs taken in order from either side of the distribution. By this method a ladder with an accuracy of 0.1% can be achieved using standard 5% resistors.

The resistor ladder drives a pair of op-amps, to produce a voltage output determined by the digital input. The CMOS i.c.s should be connected to the ZX81's 5V supply rail, but the supplies for the op-amps can be derived from batteries.

SEQUENCER PROGRAM

The following simple example shows how the interface can be used to control a synthesiser. First type into the ZX81:

```

10 REM 0000000
POKE 16514,62 (LD A,N)
POKE 16516,211 (OUT N,A)
POKE 16517,3
POKE 16518,201 (RET)

```

This stores machine code into the "0" characters in the REM statement. Now, suppose you have a series of notes whose pitches are X(N) and whose lengths are Y(N); these can be output in sequence by the operation:

```

100 POKE 16515,X(N)
110 LET A=USR 16514
120 PAUSE Y(N)
130 POKE 16437,255

```

The time needed for the BASIC calculations is negligible, so there is no advantage in coding this section in machine code; however, the ZX81 should be run in fast mode.

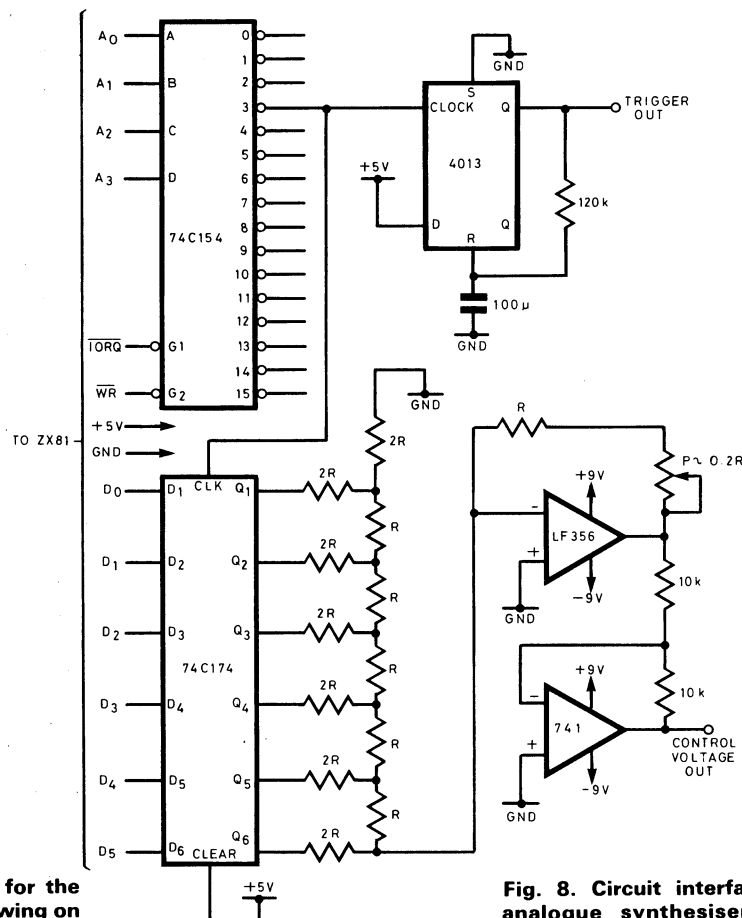


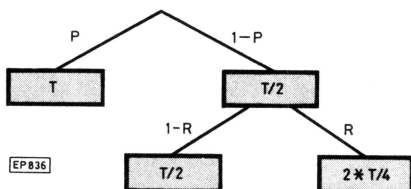
Fig. 8. Circuit interfaces an analogue synthesiser to a ZX81

ROCK IMPROVISATION

As a complete demonstration of the use of the interface, the program of Fig. 9 improvises tunes in C minor, with 4/4 time. The program chooses random notes of the scale, and random intervals of T, T/2, or 2*T/4, subject to the following constraints:

1. The relative probability of the timings can be specified.
 2. The time sequence always finishes at 4/4 periods.
 3. In the case of 2*T/4 (a rapid scale passage) the pitches are not chosen at random, but as neighbours of the preceding ones.
- In this case the time needed for the BASIC calculations is not negligible, but the timings are corrected to allow for it. The timing probabilities P and R can be seen from the scheme in Fig. 10; the values P=0.2 and R=0.2 are recommended.

Fig. 9. Scheme used for choosing the note durations in the rock improvisation



```

15 PRINT "T:T/2"
20 INPUT P
25 PRINT "2*T/4:T/2"
30 INPUT R
40 LET U=0
50 LET E=INT(8*RND)
60 POKE 16515,PEEK(16512+E)
70 IF U=72 THEN GOTO 40
80 LET A=USR 16514
90 IF U=63 THEN GOTO 200
100 LET T=9*INT(RND+P)
110 LET U=U+T+9
120 IF T=0 AND INT(RND+R)=1 THEN
N GOTO 400
125 FOR N=0 TO T/4.5
126 NEXT N
130 PAUSE 6+T
140 POKE 16437,255
150 GOTO 50
200 PAUSE 8
210 POKE 16437,255
220 GOTO 40
400 PAUSE 2
410 POKE 16437,255
420 POKE 16515,PEEK(16520+INT(3
*RND)+E)
430 LET A=USR 16514
440 PAUSE 3
450 POKE 16437,255
460 GOTO 50

```

Fig. 10. Program for the ZX81 controls a synthesiser to produce music improvisations

Before running the program the pitches of the allowed scale should be set up as follows: First add 9 more zeros to the REM statement in line 10, and then type in:

```

POKE 16520,14 (D1)
POKE 16521,12 (C1)
POKE 16522,15 (E flat 1)
POKE 16523,17 (F1)
POKE 16524,18 (G flat 1)
POKE 16525,19 (G1)
POKE 16526,22 (B flat 1)
POKE 16527,24 (C2)
POKE 16528,27 (E flat 2)
POKE 16529,26 (D2)

```

The program could be modified for use with other computers with sound output by replacing each "POKE 16515, N" statement by a statement which plays note N of the scale.

ZX81 BUS

Several readers have written in to ask for details of the ZX81 bus connections for use with circuits featured in Micro-Bus, since these are not supplied if the ZX81 is purchased assembled. Full details of the connections are therefore given in Fig. 11.

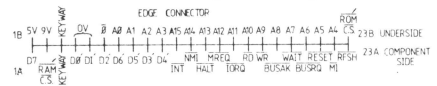


Fig. 11. Details of the ZX81 bus connections

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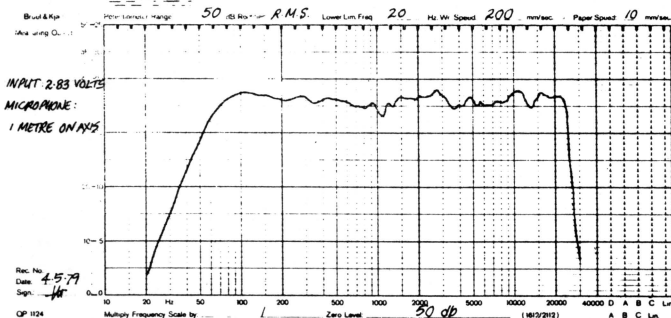
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PART 2

Jeremy Bentham

ONCE the components have been assembled into the p.c.b. and checked, and the transducer has been connected as described last month, the motor can be connected. Five wires are needed to link the motor coils and the +ve, common to their respective points on the p.c.b.: note that both +ve terminals on the motor must be connected to the common line.

TESTING

Do not connect the unit to the computer yet; first connect the p.c.b. to the supply, and monitor the supply current if possible. The unit should consume less than 30mA in the quiescent state, and there should be no signs of component overheating. If this is not the case, then switch off and re-check component orientation, soldering etc., paying particular attention to TR1, 5, 6, 7, 8 and their associated circuitry. The voltage across C3 should be checked: this should be around 5V, $\pm 0.5V$.

Assuming all is well, power up the Atom, press the Break key, and plug in the ribbon cable. Ensure that the plug is the correct way round by tracing the wire from pin 1 of the p.c.b. (see component layout) to the bottom left-hand pin of the Atom printer port, as viewed from the back of the Atom. The supply current should now have risen to around 300mA. The reason for this is the Atom port is not initialised, and all its outputs are floating to a "high" state, switching on all the motor drive transistors. If REG 1 is fitted, it will warm up: if you are feeding it with eight volts or over, then a heatsink may be necessary.

To perform a quick test of the motor drive, execute the following command on the Atom:

? 47107 = 127

This sets bits 0–6 of the port as outputs, and bit 7 as an input. The supply current should have returned to the quiescent value, since all output bits are set low. It should now be possible to step the motor. Execute the command

? 47105 = 1

This energises coil 1 of the motor, the rotor should lock onto one position. Execute in turn

? 47105 = 2

? 47105 = 4

? 47105 = 8

The transducer should have moved round in 7.5 degree steps, since you are energising each of the coils in turn. If you repeat the sequence, the motor should keep on stepping round. It is worthwhile checking that at each step the rotor is being firmly held: if not, check the circuitry associated with that coil. Now execute

? 47105 = 0

? 47105 = 64

The first command resets all outputs, the second one sets the transmit drive output, and should cause a single faint click in the transducer. Repeat these two instructions to check that a click can be heard.

If the unit is not responding to any of these commands, then check that the printer drive i.c.s have been correctly fitted within the Atom (IC1 and IC50). Try measuring the voltage on the pins of the port connector. Looking at the back of the Atom, the even pin numbers are at the top, and odd numbers at the bottom. When the initialisation command is entered, pins 3, 5, 7, 9, 11, 13, 15 should go low: when Break is pressed they should go high. All the even pin numbers should be at ground potential.

SOFTWARE

Once the unit is working, it is suggested that the program in Fig. 1 be keyed in and run. It requires 1K of graphics memory and text memory up to 3000 Hex. The objects seen by the unit are displayed on a single horizontal line, the distance away from the transducer being indicated by the distance from the left-hand margin. The transducer can be full-stepped by holding down the SHIFT or REPT keys. To make the program readily understandable, BASIC has been used for the plot routine. This makes the program run very slowly compared with the author's normal machine-code plotting, but it serves its purpose as a demonstration. Experiment with the setting of the sensitivity control, VR1. To stop the program, use the BREAK key, since this also resets the port. When using this or any other program, keep the transducer away from your TV set or monitor; many of these generate copious interference which will *lock up* the receive circuitry.

```
>LIST
10 REM COMPVIS PROGRAM
20 DIM LL(14)
30 FOR I=0 TO 14:LL(I)=P:N.
40 C=#B001
50 U=#2F80
60 FOR I=0 TO 1
70 P=#2E00
80
90% TRANSMIT ROUTINE
110:LL1 LDA @1:STA #AE:LDA C:AND @#F:TAY:ORA @#40:TAX
120 LDA @10
130:LL2 STX C:SEC:STY C:SBC @1:BNE LL2
140 LDA @10
150:LL3 STX C:SEC:STY C:SBC #AE:BNE LL3
160 LDA @10
170:LL4 STX C:SEC:STY C:NOP:SBC @1:BNE LL4
180 LDA @10
190:LL5 STX C:SEC:STY C:NOP:SBC #AE:BNE LL5
200 LDA @10
210:LL6 STX C:SEC:STY C:NOP:NOP:SBC @1:BNE LL6
220%
230% RECEIVE ROUTINE
240:LL7 LDX @0
250:LL8 LDA C:STA U,X:LDY @30
260:LL9 DEY:BNE LL9
270 INX:BFL LL8:RTS
280%
290% SHIFT ROUTINES
300:LL10 LDA C:LSR A:AND @#F:BNE LL11:LDA @8
310:LL11 STA C:RTS
320%
330:LL12 LDA C:ASL A:AND @#F:BNE LL13:LDA @1
340:LL13 STA C:RTS
350%
360 NEXT I
370 REM
380 REM INITIALISATION
390 !#208=!#208+3
400 ?#B00C=0: ?#B003=#7F: ?#B001=1
410 CLEAR 1
420 REM
430 REM TRANSMIT-RECEIVE-PLOT
440 LINK LL1
450 FOR J=0 TO 127
460 A=15:IF J>128 THEN A=13
470 PLOT A,J,10
480 NEXT J
490 REM
500 REM MOVEMENT REQUIRED?
510 IF ?#B001 & #80 =0 THEN LINK LL10
520 IF ?#B002 & #40 =0 THEN LINK LL12
530 GOTO 440
540 END
```

Fig. 1. Test Program.
**Note: The % symbols should be replaced by backslashes **

It is beyond the scope of this article to give details of the software used for the radar-type plots in the photographs. It is hoped to make this and other software available on cassette together with annotated listings. However, there follows a description of the test software, to assist those wishing to convert it to another machine or write their own. To those of you unfamiliar with the Atom, the software must appear very peculiar, since it contains a mix of BASIC and 6502 assembly language. In other machines it will be necessary to assemble the machine code separately, and then join it on to the Basic. Lines 20, 30, 60, 360 are used to manipulate the Atom assembler, and are not otherwise required. Lines 40, 50 set two variables for use by the assembler, and line 70 sets the start address for the assembled code. The assembly language section is delimited by the square brackets in lines 80, 350. The mnemonics are standard 6502, except that immediate addressing is indicated by @, and a hash sign indicates a hex number. Multiple mnemonics per line are permitted if separated by a semicolon, and line labels are indicated by :LL followed by a number.

The program can be split into five sections: initialisation, transmission, reception, plotting and movement.

INITIALISATION

The Atom printer port uses a 6522 Versatile Interface Adaptor, addressed at locations B800 to B80F hex. The important addresses are:

B80C control of mode and handshaking

B803 port A directional register

B801 port A input and output

The vision system uses the following bits of port A:

Bits 0, 1, 2, 3 motor drive for coils 1, 2, 3, 4 (O/Ps)

Bit 6 transmit signal (O/P)

Bit 7 received signal (I/P)

When initialising the port for user I/O, it is necessary first to isolate it from the normal print drive routines, using the statement in line 390. Non-Atom users will no doubt be mystified by the use of the exclamation mark: it is being used to both PEEK and POKE a four-byte location! Line 400 sets the port to normal I/O without handshaking, sets bit 7 as an input and the rest as outputs, then turns on the driver for motor coil 1. Here, the question mark is used as a POKE command. The CLEAR 1 command in line 410 sets graphics mode 1 and clears the screen.

TRANSMISSION

Line 440 causes the BASIC program to execute the machine code at line 110, which is the transmit routine. This routine generates 10 cycles of each of the following frequencies: 66.7, 62.5, 58.8, 55.5, 52.6kHz. Since the frequencies are so high, it is necessary to use carefully-timed machine-code instructions. The routine needs one zero-page location; I have used AE hex, but any free location will do. Line 110 sets the X and Y registers with the port data: X has the transmit bit set, and Y has it reset. Each of the following

FULL STEPPING					
	STEP NO.	1	2	3	4
0 ▲	*				*INDICATES THE COIL IS ENERGISED IN THE STEP
CLOCKWISE MOVEMENT	1		*		
	2			*	
	3				
ANTICLOCK- WISE MOVEMENT	4	*			
	5		*		
	6			*	
	etc				
HALF STEPPING					
	STEP NO.	1	2	3	4
0 ▲		*			*INDICATES THE COIL IS ENERGISED IN THE STEP
	$\frac{1}{2}$	*	*		
CLOCKWISE MOVEMENT	1		*		
	$1\frac{1}{2}$		*	*	
	2			*	
	$2\frac{1}{2}$			*	
ANTICLOCK- WISE MOVEMENT	3	*			
	$3\frac{1}{2}$	*			
	4	*			
	$4\frac{1}{2}$	*	*		
	etc				

**Fig. 2. Step-
ping motor
control**

pairs of lines generates one frequency, with a fixed 6 microsecond "on" pulse and the corresponding "off" time. Strictly speaking, the machine code should be located away from a page boundary, otherwise a page crossing will make one of the frequencies incorrect.

RECEPTION

This machine-code routine follows straight on from the transmission, since any delay would result in data being lost. The X register is used as a pointer into a storage area from 2F80 to 3000 hex. Periodically, all 8 bits of the port are stored, and the pointer is incremented. In fact, bits 0 to 6 are being stored unnecessarily, since bit 7, the echo return, is the only one of interest. Line 260 serves to slow down the storage process, the amount of delay being set at the end of line 250. Changing the value from 30 will change the effective range that is stored and later plotted.

PLOTTING

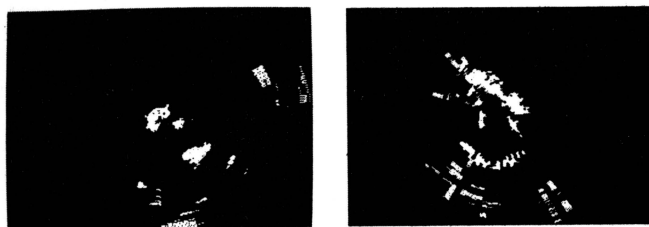
Lines 450 to 480 take the data just stored and plot it as a horizontal line. The line is composed of 128 separate points, so it is hardly surprising that the BASIC routine is slow. The question mark in line 460 is being used as an equivalent to PEEK (J+U). This is used to set A to 13 (to plot) or 15 (to unplot). It must be remembered that the output from the p.c.b. is normally high, and is held low in the presence of an echo.

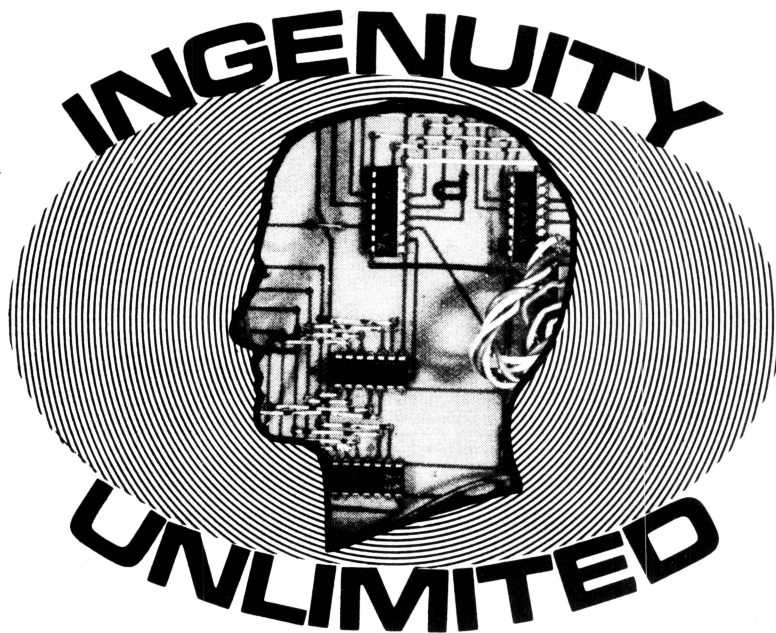
MOVEMENT

Lines 510 and 520 detect whether the SHIFT or REPT keys have been pressed. If so, then the machine code to step the motor clockwise or anticlockwise is called. The sequence of signals to step the motor can be best understood by reference to Fig. 2. It should be noted that the motor is being full-stepped (7.5 deg. per step). If the signals were fed to the motor in the sequence described in the lower table, then each step would be half that value. Due to the tolerances in motor manufacture, the positional accuracy is worse when half-stepping, but it should be more than adequate for our needs, and there is no cumulative error.

DEVELOPMENT

Finally, if the reader comes up with any novel modifications, developments or applications for the Ultrasonic Vision System, then do write to P.E. All such ideas will be considered for publication. ★





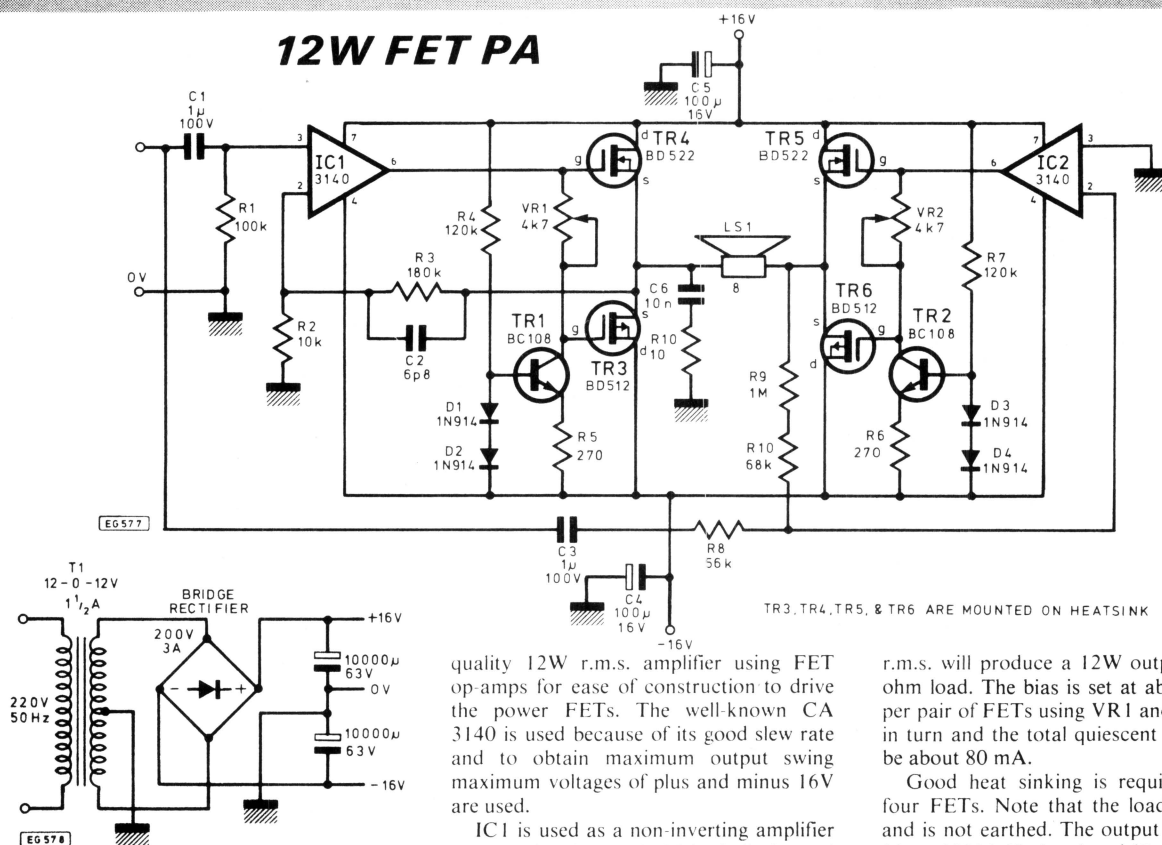
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Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

12W FET PA



POWER FETs of the BD 512/522 series are relatively inefficient because of their large gate threshold voltage of some 2.5V and their high internal resistance. In a source follower mode the output voltage swing is only 65% of that on the gate for an 8 ohm load and typical transconductance. However, these problems can be overcome on low voltage power supplies if a bridge amplifier is used. The circuit shown is for such a high

quality 12W r.m.s. amplifier using FET op-amps for ease of construction to drive the power FETs. The well-known CA 3140 is used because of its good slew rate and to obtain maximum output swing maximum voltages of plus and minus 16V are used.

IC1 is used as a non-inverting amplifier with a gain of 19 and IC2 is similarly used but in the inverting mode. Input impedance is determined by R1 and R8 in parallel. TR1 (TR2 similarly) is a constant current sink of $1\frac{1}{2}$ mA (the only concession to bipolars) and VR1 sets the bias of the power FET pair TR4 and TR3. VR2 sets the bias of TR5 and TR6 which are driven in opposite phase to TR4 and TR3.

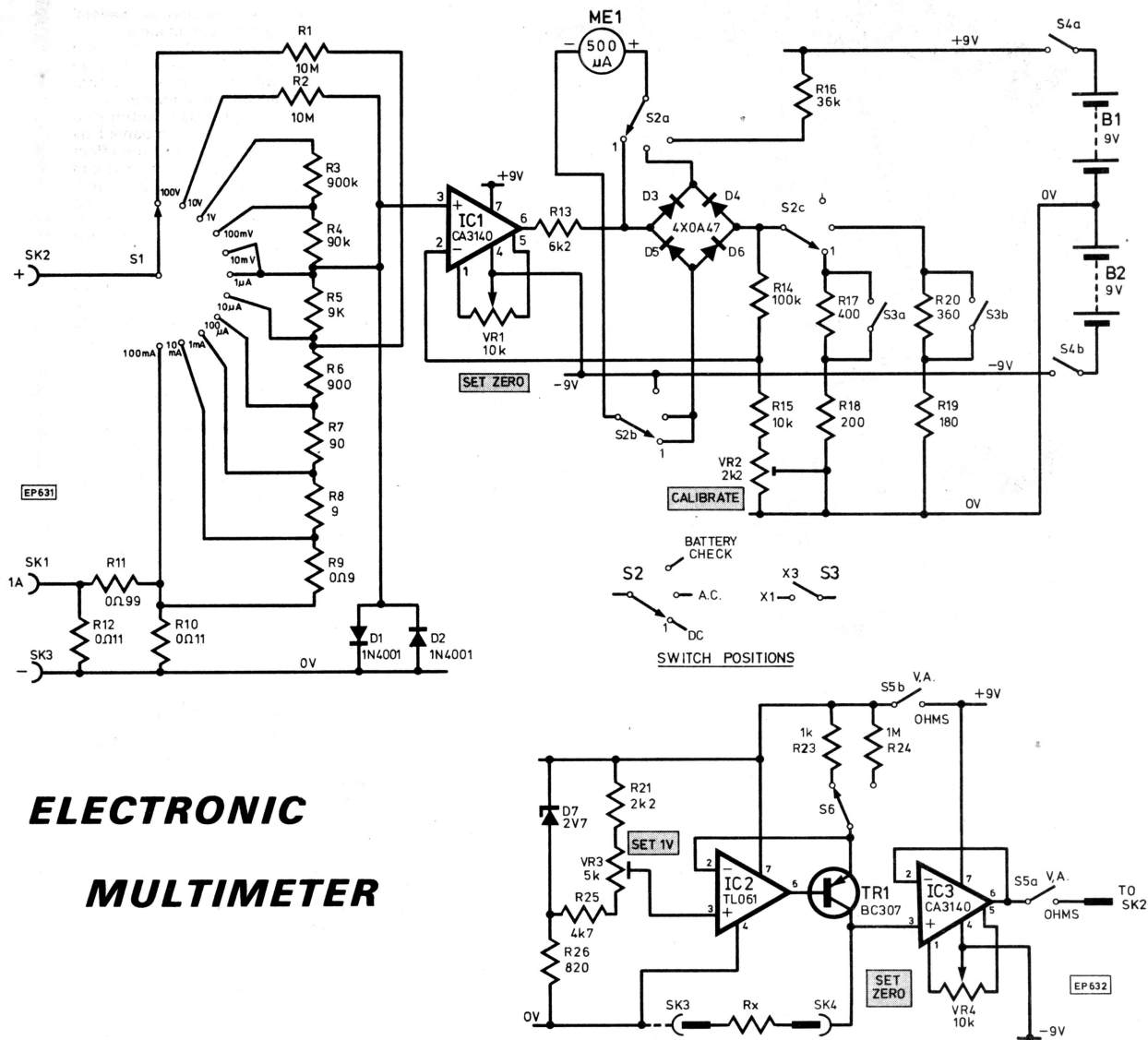
The amplifier is capable of working to hundreds of kHz so C2 is used to reduce gain above 20kHz. An input of 500mV

r.m.s. will produce a 12W output on an 8 ohm load. The bias is set at about 30 mA per pair of FETs using VR1 and VR2 each in turn and the total quiescent current will be about 80 mA.

Good heat sinking is required for the four FETs. Note that the load is floating and is not earthed. The output is flat from 20 to 20000 Hz but is $-1\frac{1}{2}$ dB at these extremes. Distortion is low and noise is about -80 dB.

By bypassing C1 and C3 the amplifier responds to a d.c. input but quiescent offset voltage across the load caused by op-amp imbalance may have to be trimmed out.

R. Immelman,
Somerset West,
South Africa.



ELECTRONIC MULTIMETER

THIS multimeter design has an input impedance of $1\text{M}\Omega/\text{V}$ or $333\text{k}\Omega/\text{V}$ depending on whether one is reading in decade multiples of 1 or $3\text{V/mV/A/mA}/\mu\text{A}$. The f.s.d. ranges are 10mV to 300V , $1\mu\text{A}$ to 3A a.c. or d.c. Protection is by D1, 2 and by R13.

An additional, optional ohmmeter circuit can be included although it was not built into the prototype to avoid circuit complication. However it has been very successfully used in conjunction with the prototype. Resistances from 10Ω (f.s.d.) to about $6\text{M}\Omega$ can be measured on a linear scale.

The input voltage or current is converted by resistor chain R1–12 to a voltage at pin 3 of IC1 of up to 10 or 30mV . This voltage is amplified tenfold to $100/300\text{mV}$. Resistors R17–20 convert this output to a meter current of up to $500\mu\text{A}$. The meter rectifier section is arranged so as to make the germanium diodes' forward voltage drop immaterial and the $6\text{k}2$ resistor limits

meter current to 1.2mA , in case of overload. The d.c. range is connected so that wrong polarity inputs are not transmitted to the meter. The a.c. range has no capacitors and can be used as a null detector which always gives a positive meter deflection. Should d.c. level elimination be required, a capacitor can be put in the input test prods of value chosen to have low reactance.

Position 3 of S2 selects an independent battery check function. The meter reads full scale when the mean battery voltage is 9V .

The optional resistance measuring circuitry is a constant current source which sends 1mA or $1\mu\text{A}$ through a test resistor R_x connected to sockets SK3, 4. IC3 is a buffer stage which allows the 10mV to 10V d.c. voltage ranges to measure the p.d. across R_x without altering its value.

Resistors R3–7 are made by adding preferred values such as 15 and 75, or 43 and 47 in their decade multiples. They

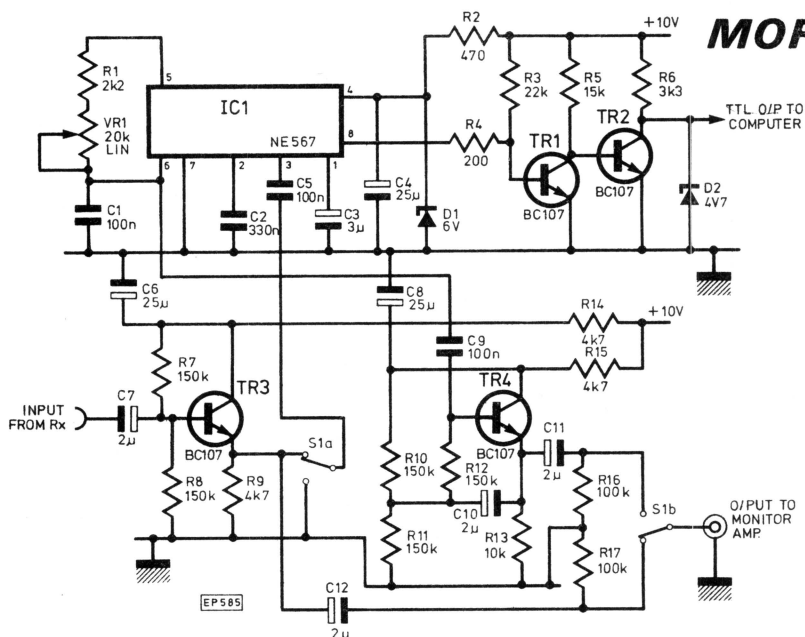
must be 2% types. R8 is 10Ω 2% and 91Ω 5% in parallel. R14, 18–20, 23, 24 are also 2%. R9–12 are made from constantan wire: 24 SWG is about $2.00\Omega/\text{m}$ and 30 SWG is $6.29\Omega/\text{m}$. To standardise the wire accurately, a known current of about 10mA is passed through a sample and the rest of the multimeter (R8 connected to common line) used to measure the p.d./unit length. From this the resistance/unit length and hence required lengths are calculated.

R17 is a parallel combination of 470Ω 2% and $2\text{k}7$ 5%.

With the test prods from SK2, 3 shorted together, VR1 is adjusted for zero meter deflection. In the ohmmeter, VR3 is adjusted to set the test currents to 1mA and $1\mu\text{A}$. With SK3, 4 shorted, VR4 is adjusted for zero output from IC3.

J. H. Greaves,
Ealing.

MORSE TONE DETECTOR



THE accompanying design has been used by the writer to detect the morse code tones found on the amateur bands. It takes its input from the audio output socket of a communications receiver or other radio, at line level, i.e. about 200mV peak to peak. It produces a single bit TTL compatible output, which can be fed directly into a computer port.

The circuit is based on the NE 567 phase-locked-loop (PLL) integrated tone detector. The natural frequency of the oscillator on the chip is set by the time constant of VR1 and C1. If there is a tone present on the input, whose frequency is within ± 10 per cent of the oscillator's natural frequency, then the output will go low. This capture range is set by the value

of capacitor C2. C3 performs 'anti-bounce' decoupling on the output.

The manufacturers claim that the device will find a tone buried under six times its amplitude of noise. This means that virtually all humanly detectable morse tones are recoverable. The setting of VR1 is most easily performed by someone with a musical ear, in conjunction with switch S1. When switch S1 is pressed, S1a disconnects the receiver from the PLL, so that it runs at its natural frequency, and S1b connects the monitor audio amplifier to the PLL oscillator, so that a steady note, whose frequency depends on the setting of VR1, is heard. To tune into one particular tone, VR1 is simply adjusted to give the same pitched note when S1 is pressed, as is heard from the receiver when S1 is released.

The device has been found to work quite happily when two or more stations of equal loudness, but different tones, are transmitting simultaneously. The results have been beautifully punctuated weather reports and news items in many languages displayed on the computer VDU. Also, with a smaller value capacitor for C3, the device could possibly be used for receiving RTTY communications.

D. Greaves,
Crampmoor,
Romsey.

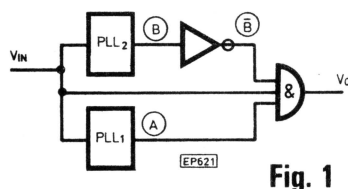


Fig. 1

IN Fig. 1 we can see the principle of this bandpass filter. There are two rectangles which have been marked PLL1 and PLL2 (PLL is a phase locked loop). The bandpass filter includes also NOT and AND ports. V_{in} is conducted to the PLLs and the AND port. This can be a squarewave or a sinewave. Its voltage must be sufficiently high that the AND port can go to a high state.

The circuit diagram of the complete bandpass filter is in Fig. 2. PLL1 is tuned with the preset pot VR1 to the lower limit frequency (cut off frequency f_L) of the band which we want to select. PLL2 is tuned with the preset pot VR2 to the higher limit frequency (cut off frequency f_H) of the same band.

I have selected from the circuit 4046 the part (the phase comparator) which doesn't lock to the harmonic frequencies of the base frequency but only to one base frequency.

The output of the PLL2 is inverted. Now we can get the high state outputs from both the PLLs over the band which we want to use.

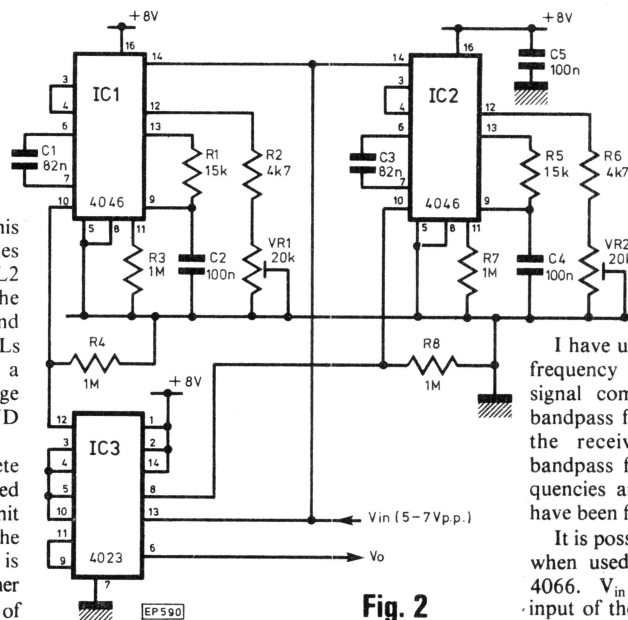


Fig. 2

The AND port works as a digital comparator. The squarewave signal comes out on the selected band but has the disadvantage that it has a fixed level about the supply voltage. The band can be selected on the wide range around 1kHz with the component values marked in the circuit. The bandwidth can be narrowed or widened as required.

I have used this bandpass filter before a frequency shift keying demodulator. A signal comes from the receiver to this bandpass filter. The sinewave signal from the receiver is triggered before the bandpass filter. The space and mark frequencies are 1070Hz and 1270Hz which have been filtered out.

It is possible to get out a sinewave signal when used with a switch e.g. a CMOS-4066. V_{in} must be conducted to the input of the switch instead of the input of the AND port and, of course, to the inputs of the PLLs. The output of the AND port drives the switch. From the output of the switch we can get the sinewave signal on the wanted band. A disadvantage is that the level of V_{in} must be inside the determined values.

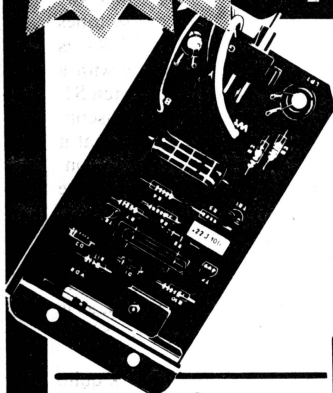
Touko Valtamo,
Tampere,
Finland.

BANDPASS FILTER

Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

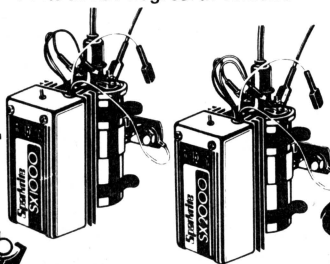
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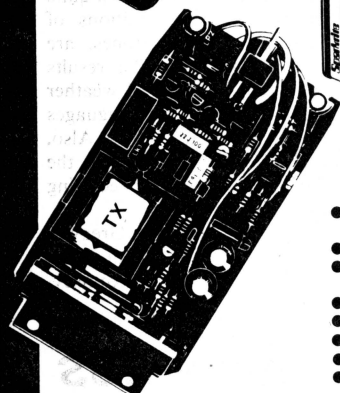
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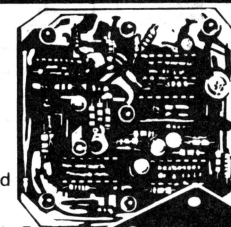
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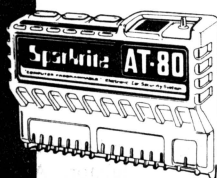
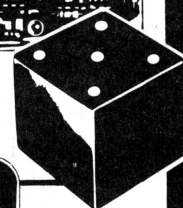
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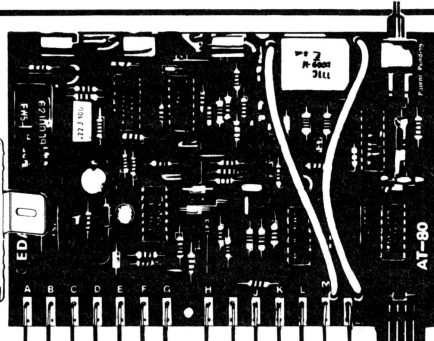
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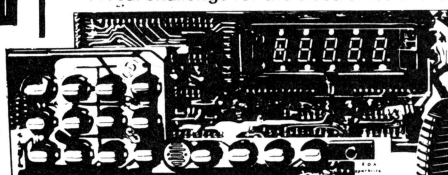
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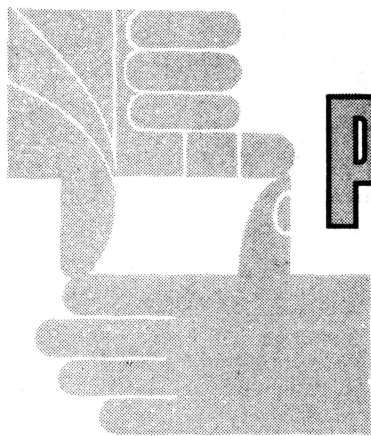
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DRIVING MUSIC

There's an interesting story, and a patent, behind the Record Runner[®] reported in Practical Electronics February 1982 (page 17). The Record Runner is a model VW van which drives round a record and plays it. It's covered by US patent 4 232 202 which was granted to Sony of Japan. The inventors Yoshihisa Mori, Norio Mashimo and Takeo Eguchi are all designers in the department of Sony which deals with hi fi record players and pickup cartridges. Yoshihisa Mori is not only an engineer, he's also a hi fi enthusiast and VW car enthusiast. Back in 1977 Mori built a toy VW minibus which ran round a disc and played it. That early prototype, which was briefly shown at the Paris Festival du Son and in Sony's showroom in Regent Street, was a primitive affair. It ran at constant linear speed and so tracked a record at progressively incorrect rotational speed. This is because the linear distance of a groove full turn varies from disc edge to disc centre. Subsequently Mori built a clever modification into his gramocar which

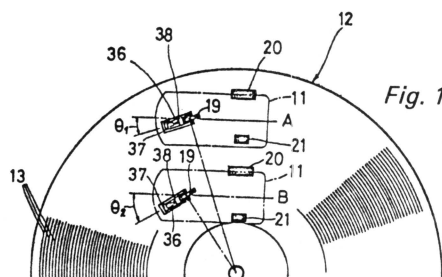
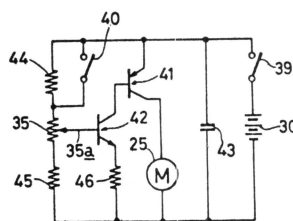


Fig. 2



enables it to change running speed automatically and continuously as it tracks in across the disc and so keep the playing speed constant at around 33 $\frac{1}{3}$ rpm. This modification is described in US patent 4 232 202.

Sony decided against manufacturing and selling the gramocar under the Sony brand

name. "We are a hi fi company, not a toy company" they told me last year. But now the car is on sale in Japanese shops under a different brand name and this is how it has found its way into Britain as an import.

The patent describes how the playing speed is kept constant. On board the car there is a small amplifier and loudspeaker and the pickup and stylus are mounted on an undercarriage. This is pivoted like a short gramophone tone arm, so as the car tracks in towards the centre of the disc the arm turns slightly around the pivot. This angular movement changes the value of the variable resistor which controls the motor speed to maintain a constant angular or rotational tracking velocity.

Figure 1 of the patent shows how the angle of the undercarriage and pickup changes as the car tracks in across the disc. Figure 2 shows the speed control circuit for a motor 25, which drives the car wheels. Angular movement of the undercarriage causes movement of the tap 35a of variable resistor 35 so that the base voltage applied to transistor 42 is decreased. This brings a corresponding decrease in the supply of current through transistor 41 to motor 25. So the motor drive speed, and thus the speed of the vehicle, progressively decreases as it moves towards the disc centre.

ENGLISH TRANSLATIONS

An assured growth area for the future is the automated translation of text and spoken language. Most of the major electronics firms, especially in Japan, already have research programmes underway. For the Japanese there is a special incentive to automate the translation of written text and spoken words. This is very clearly explained in recently granted British patent no 1 596 411, from the Kyodo News Service of Tokyo, Japan. The patent claims a computerised translation system intended primarily to speed up the transmission of telexes to and from Japan. The lengthy patent text, 37 pages of description and 34 pages of descriptive drawings, is too complex to discuss in detail. But essentially the Kyodo computer programme searches phonetically in a memory of phrases. In a first scan of the memory the computer hunts for a translation that exactly corresponds to a character train. If this scan fails, the last character of the train is dropped and the search made again. This

continues, with the last character of the train being dropped each time, until there is an exact phonetic match between an index word stored in the computer memory and a character in the input train.

The patent is of more general interest because of its introduction. This explains the daunting task facing anyone who sets out to automate translation between the Japanese and English languages.

Most Japanese sentences are made up from five different kind of characters. *Kanji*, are Chinese picture characters representing phonetic expressions. *Hiragana* and *katakana* (generically called *kana*) are syllables characters representing components of words. Then there are Roman alphabetical characters, used where no equivalent Japanese character exists, and Arabian figures. There are tens of thousands of kanjis, although only 1850 are permitted for use in official documents. But 2,500 appear in newspapers and 5,000 are likely to be encountered in everyday life. There are 75 hiragana and katakana making a total of 150 kana. A recent survey

showed that in Japanese expressions, 63% of the characters are kanji and 36% kana. Because of the difficulties in converting kanji and kana into International telex code, and converting Roman code into kanji and kana, any organisation involved in international communication usually translates before transmission. Kyodo estimates that it spends 30 billion Japanese yen a year on communication translations! It is a fact that most Japanese firms with subsidiary companies in the West simply give up and communicate both ways by telex in English. This is the background to patents on computerised translation such as BP 1 596 411. It is likely that over the next decade there will be many, many more.

In the February Patents Review, which dealt with a Texas Instruments patent, we mentioned that another Texas educational toy 'Speak and Maths' is available in America. Texas have informed us that 'Speak and Maths' is also available in this country.

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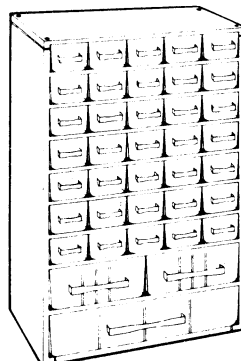
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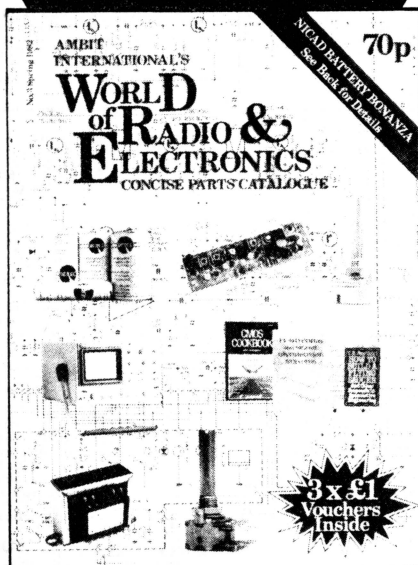
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INDEX TO ADVERTISERS

Ace Mailtronix	80
Adam Hall Supplies	78
A.D. Electronics	14
Alcon	40
Ambit	75
Aura Sounds	30
Barrie	78
Bicc Vero	48
Bi-Pak	13
Blackstar	14
British National Radio & Electronics School	8
Cambridge Kits	78
Cambridge Learning	14
Clef Products	8
Crofton Electronics	12
C.R. Supply Co.	78
Davies N.V.	76
Dorman Smith	22
E.D.A.	71
Electronize Design	12
Electrovalue	12
Enfield Electronics	4
Gemini	74
Global Specialties Corporation	5
Hameg	56
Heathkit	40
ICS Intertext	73
ILP Electronics	9, 73
Knight A.	76
L & B Electronics	48
Lincolnshire Area Health Authority	77
London Electronics College	77
Maplin Electronics	Cover 4
Micro-print Limited	78
Microstate Limited	76
Midwich Computers	7
Millhill	74
Modern Book Co.	79
Modus Systems	75
Namal	74
Parndon	80
Phonsonics	74
Pimac	4
PKG Electronics	77
Polytechnic of the South Bank	77
Powell T.	14
Powertran	Cover 2
Radio Component Specialists	79
Radio & T.V. Components	16
Response Company	76
Scientific Wire Co	77
Sinclair Research	10, 11
Solid State	80
Swanley	4
Technomatic	80, Cover 3
Tempus	6
T.K. Electronics	15
Videotone	56
Watford Electronics	2, 3
William Stuart Systems (Big Ears)	78
Wilmslow Audio	75

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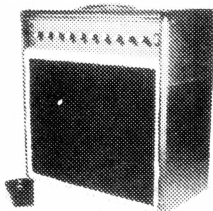
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7411	20p	74LS10	15p	74LS549	4015	AY1-1313	200p
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7414	22p	74LS13	25p	74LS552	4018	AY1-1313	200p
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7416	25p	74LS15	30p	74LS554	4020	AY1-1313	200p
7417	25p	74LS20	15p	74LS555	4021	AY1-1313	200p
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7421	20p	74LS22	15p	74LS557	4023	AY1-1313	200p
7422	22p	74LS23	15p	74LS558	4024	AY1-1313	200p
7423	22p	74LS24	15p	74LS559	4025	AY1-1313	200p
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7430	15p	74LS33	16p	74LS565	4031	AY1-1313	200p
7431	15p	74LS33	16p	74LS566	4032	AY1-1313	200p
7432	15p	74LS33	16p	74LS567	4033	AY1-1313	200p
7433	27p	74LS42	36p	74LS568	4034	AY1-1313	200p
7437	27p	74LS47	40p	74LS569	4035	AY1-1313	200p
7440	17p	74LS48	18p	74LS570	4036	AY1-1313	200p
7441	17p	74LS51	18p	74LS571	4037	AY1-1313	200p
7442A	17p	74LS51	18p	74LS572	4038	AY1-1313	200p
7445	60p	74LS55	30p	74LS573	4039	AY1-1313	200p
7446A	93p	74LS74	16p	74LS574	4040	AY1-1313	200p
7447A	45p	74LS75	24p	74LS575	4041	AY1-1313	200p
7450	17p	74LS76	20p	74LS576	4042	AY1-1313	200p
7451	17p	74LS83	45p	74LS577	4043	AY1-1313	200p
7453	17p	74LS85	45p	74LS578	4044	AY1-1313	200p
7454	17p	74LS85	45p	74LS579	4045	AY1-1313	200p
7472	30p	74LS90	28p	74LS580	4046	AY1-1313	200p
7473	30p	74LS92	40p	74LS581	4047	AY1-1313	200p
7476	30p	74LS93	30p	74LS582	4048	AY1-1313	200p
7483A	45p	74LS95	40p	74LS583	4049	AY1-1313	200p
7485	60p	74LS107	45p	74LS584	4050	AY1-1313	200p
7486	22p	74LS109	30p	74LS585	4051	AY1-1313	200p
7489	210p	74LS112	34p	74LS586	4052	AY1-1313	200p
7490A	25p	74LS113	30p	74LS587	4053	AY1-1313	200p
7491	45p	74LS114	30p	74LS588	4054	AY1-1313	200p
7492A	30p	74LS114	30p	74LS589	4055	AY1-1313	200p
7493A	30p	74LS123	50p	74LS590	4056	AY1-1313	200p
7494	40p	74LS124	120p	74LS591	4057	AY1-1313	200p
7495A	50p	74LS125	30p	74LS592	4058	AY1-1313	200p
7496	120p	74LS126	30p	74LS593	4059	AY1-1313	200p
7497	120p	74LS127	30p	74LS594	4060	AY1-1313	200p
74100	85p	74LS133	30p	74LS595	4061	AY1-1313	200p
74107	22p	74LS136	30p	74LS596	4062	AY1-1313	200p
74109	30p	74LS138	34p	74LS597	4063	AY1-1313	200p
74118	60p	74LS139	36p	74LS598	4064	AY1-1313	200p
74119	75p	74LS145	35p	74LS599	4065	AY1-1313	200p
74120	70p	74LS148	90p	74LS600	4066	AY1-1313	200p
74121	27p	74LS151	30p	74LS601	4067	AY1-1313	200p
74122	45p	74LS153	40p	74LS602	4068	AY1-1313	200p
74123	45p	74LS154	40p	74LS603	4069	AY1-1313	200p
74125	40p	74LS155	40p	74LS604	4070	AY1-1313	200p
74126	40p	74LS156	40p	74LS605	4071	AY1-1313	200p
74128	40p	74LS157	35p	74LS606	4072	AY1-1313	200p
74132	30p	74LS158	36p	74LS607	4073	AY1-1313	200p
74136	32p	74LS160	40p	74LS608	4074	AY1-1313	200p
74141	65p	74LS161	40p	74LS609	4075	AY1-1313	200p
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74145	50p	74LS163	40p	74LS611	4077	AY1-1313	200p
74147	100p	74LS164	40p	74LS612	4078	AY1-1313	200p
74148	75p	74LS165	100p	74LS613	4079	AY1-1313	200p
74150	60p	74LS166	100p	74LS614	4080	AY1-1313	200p
74151A	45p	74LS170	90p	74LS615	4081	AY1-1313	200p
74153	45p	74LS173	90p	74LS616	4082	AY1-1313	200p
74154	60p	74LS174	45p	74LS617	4083	AY1-1313	200p
74155	50p	74LS175	45p	74LS618	4084	AY1-1313	200p
74156	35p	74LS181	140p	74LS619	4085	AY1-1313	200p
74159	100p	74LS182	140p	74LS620	4086	AY1-1313	200p
74160	60p	74LS192	50p	74LS621	4087	AY1-1313	200p
74161	60p	74LS193	48p	74LS622	4088	AY1-1313	200p
74162	60p	74LS194	40p	74LS623	4089	AY1-1313	200p
74163	60p	74LS195	40p	74LS624	4090	AY1-1313	200p
74164	60p	74LS196	40p	74LS625	4091	AY1-1313	200p
74165	55p	74LS200	40p	74LS626	4092	AY1-1313	200p
74166	55p	74LS221	60p	74LS627	4093	AY1-1313	200p
74170	140p	74LS240	80p	74LS628	4094	AY1-1313	200p
74172	300p	74LS241	80p	74LS629	4095	AY1-1313	200p
74173	65p	74LS242	80p	74LS630	4096	AY1-1313	200p
74174	60p	74LS243	80p	74LS631	4097	AY1-1313	200p
74175	60p	74LS244	80p	74LS632	4098	AY1-1313	200p
74176	50p	74LS245	90p	74LS633	4099	AY1-1313	200p
74177	70p	74LS251	40p	74LS634	4100	AY1-1313	200p
74178	100p	74LS253	40p	74LS635	4101	AY1-1313	200p
74180	100p	74LS257	45p	74LS636	4102	AY1-1313	200p
74181	130p	74LS258	45p	74LS637	4103	AY1-1313	200p
74182A	90p	74LS259	45p	74LS638	4104	AY1-1313	200p
74184A	90p	74LS260	24p	74LS639	4105	AY1-1313	200p
74185	120p	74LS266	25p	74LS640	4106	AY1-1313	200p
74186	500p	74LS273	70p	74LS641	4107	AY1-1313	200p
74188	325p	74LS276	20p	74LS642	4108	AY1-1313	200p
74190	50p	74LS280	25p	74LS643	4109	AY1-1313	200p
74191	50p	74LS283	25p	74LS644	4110	AY1-1313	200p
74192	50p	74LS293	50p	74LS645	4111	AY1-1313	200p
74193	50p	74LS295	200p	74LS646	4112	AY1-1313	200p
74194	70p	74LS298	40p	74LS647	4113	AY1-1313	200p
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74196	60p	74LS323	25p	74LS649	4115	AY1-1313	200p
74197	60p	74LS324	180p	74LS650	4116	AY1-1313	200p
74198	100p	74LS348	150p	74LS651	4117	AY1-1313	200p
74199	100p	74LS352	100p	74LS652	4118	AY1-1313	200p
74201	60p	74LS353	100p	74LS653	4119	AY1-1313	200p
74202	60p	74LS354	100p	74LS654	4120	AY1-1313	200p
74203	150p	74LS355	100p	74LS655	4121	AY1-1313	200p
74204	150p	74LS356	100p	74LS656	4122	AY1-1313	200p
74205	150p	74LS357	100p	74LS657	4123	AY1-1313	200p
74206	150p	74LS358	100p	74LS658	4124	AY1-1313	200p
74207	150p	74LS359	100p	74LS659	4125	AY1-1313	200p
74208	150p	74LS360	100p	74LS660	4126	AY1-1313	200p
74209	150p	74LS361	100p	74LS661	4127	AY1-1313	200p
74210	150p	74LS362	100p	74LS662	4128	AY1-1313	200p
74211	150p	74LS363	100p	74LS663	4129	AY1-1313	200p
74212	150p	74LS364	100p	74LS664	4130	AY1-1313	200p
74213	150p	74LS365	100p	74LS665	4131	AY1-1313	200p
74214	150p	74LS366	100p	74LS666	4132	AY1-1313	200p
74215	150p	74LS367	100p	74LS667	4133	AY1-1313	200p
74216	150p	74LS368	100p	74LS668	4134	AY1-1313	200p
74217	150p	74LS369	100p	74LS669	4135	AY1-1313	200p
74218	150p	74LS370	100p	74LS670	4136	AY1-1313	200p
74219	150p	74LS371	100p	74LS671	4137	AY1-1313	200p
74220	150p	74LS372	100p	74LS672	4138	AY1-1313	200p
74221	150p	74LS373	100p	74LS673	4139	AY1-1313	200p
74222	150p	74LS374	100p	74LS674	4140	AY1-1313	200p
74223	150p	74LS375	100p	74LS675	4141	AY1-1313	200p
74224	150p	74LS376	100p	74LS676	4142	AY1-1313	200p
74225	150p	74LS377	100p	74LS677	4143	AY1-1313	200p
74226	150p	74LS378	100p	74LS678	4144	AY1-1313	200p
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74228	150p	74LS380	100p	74LS680	4146	AY1-1313	200p
74229	150p	74LS381	100p	74LS681	4147	AY1-1313	200p
74230	150p	74LS382	100p	74LS682	4148	AY1-1313	200p
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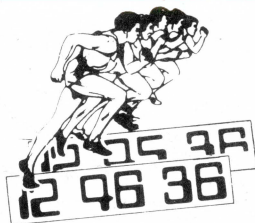
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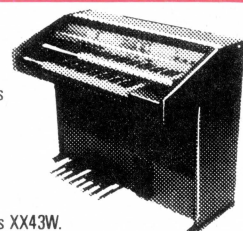


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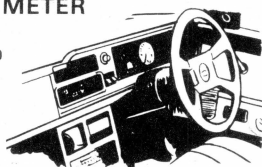
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